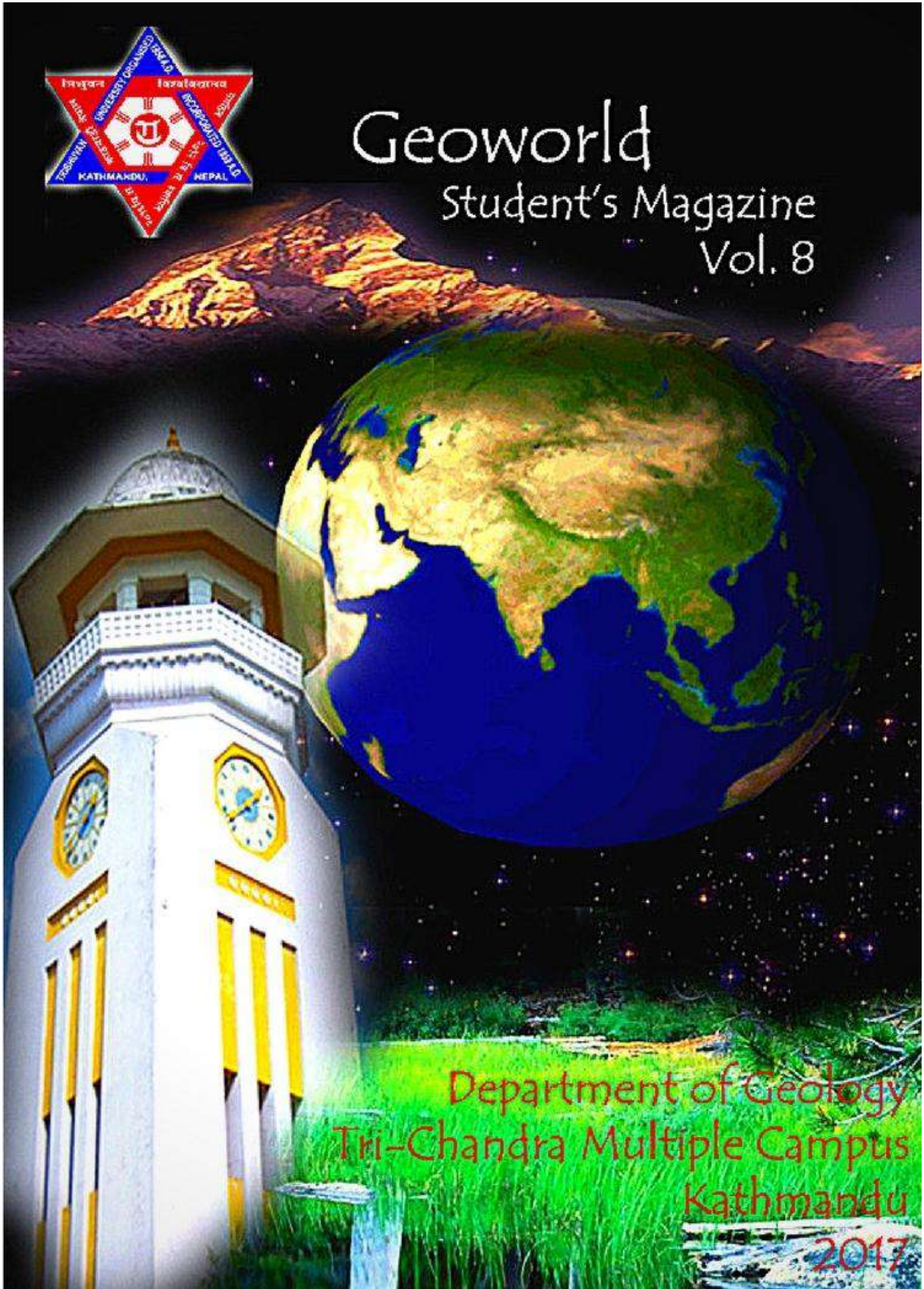
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2017

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Tribhuvan University
Tri-Chandra Multiple Campus
(Estd. 1918 A.D.)

Office of the Campus Chief
Saraswati Sadan,
Kathmandu, Nepal.

Ref. No.:-

Date: September 17, 2017

Message from the Campus Chief

I am delighted to know that Bsc 4th year students are going to publish yearly magazine entitled "Geoworld Vol.8, 2017".

This magazine includes overviews of different articles related to the project and research work.

I hope that this publication will help to desseminate the knowledge to the researchers on the related field.

I congratulate my Professors and students, Department of Geology and dedicated team for their efforts to bring out this issue infront of us.

Thank you

P.B Neupane

Prof. Pradeep B Neupane Ph.D.
Campus Chief

Ph. No. 4-244047

Tribhuvan University
Tri-Chandra Multiple Campus
(Estd. 1918 A.D.)

Office of the Campus Chief
Saraswati Sadan,
Kathmandu, Nepal.

Ref. No.:-

Date: 8 September 2017

GOODWILL MESSAGE FROM THE HEAD
DEPARTMENT OF GEOLOGY
TRI-CHANDRA CAMPUS

It gives me immense pleasure to know that our students of B.Sc. Geology 4th year (2070 Batch) are going to publish a new issue of this souvenir GEOWORLD VOL. 8, 2017 as before, so firstly I would like to congratulate them.
The publication comprised of the articles written by the Geo students, related to geology and human-earth interactions, which are undoubtedly a burning issue and will help to build awareness for the future life as well.

The importance of Geology for present day is interestingly growing in the whole globe. The increasing number of students and opening of the departments of Geology in other districts are some examples of our country. In this context, this publication will help to throw light even more for popularize the subject 'Geology' to more and more field.

Finally, I hope the continuous effort of our students since many years becoming fruitful for our country not only on the aspect of academic importance, but also on the aspect of awareness to save our country from different natural calamities as well as geo-hazards. So I on behalf of our entire department family would like to express our deep gratitude for the excellent effort made by our students.

Thank you all.

.....

Madan Ratna Manandhar
Associate Professor and Head
Department of Geology

Published by:

Department of Geology
Tri-Chandra Multiple Campus
Tribhuvan University

Ghantaghar,
Kathmandu, Nepal

Knowledge should be available to everyone for the betterment of their lives. GEOWORLD VOL-8, 2017 is a continuation of this tradition of dissemination of the knowledge.

We are extremely glad that we got the opportunity to publish this academic magazine. Thanks to our contributors, we have been able to include essays and scientific articles, along with their autobiographies.

We would like to express our deep gratitude to Prof. Dr Tara Nidhi Bhattarai for his continuous support and encouragement to publish this magazine. We would again like to thank all the contributors, who have also shown concerns on the publication of this magazine. We must thank all the faculty members, and the administration, without whose support, the articles would not have come up.

We are very much excited about this magazine, and we hope our readers will also find it exhilarating and navigating through all of the information within the articles. Though every care has been taken to remove the mistakes, critical comments regarding the magazine are highly commendable. We would be grateful for any feedback.

Thank you!!

THE EDITORIAL BOARD
Geoworld Vol. 8, 2017

A Message from the Chief Editor

Science is one of the two fundamental systems, the other being faith which implores us to live life as it is and accept what comes in life as the will of God or fate, that drives humanity. Science, on the other hand, urges us to transcend the boundaries that are created by our surrender to the fate. The advancement in medicine and technology is the result of inquisitive minds who studied the nature and imagined what else they could do with the knowledge they gained. They also disseminated the knowledge they obtained so that it would not be lost with time. Science becomes unimportant if it does not serve the public.

As students of Geology, a branch of science, we have gained some fundamental knowledge about the Earth and how it works during the four-year B.Sc. programme. We have learnt to observe the rocks and soils, to ask what they are and why they are there. We have familiarized ourselves with the Earth processes and the benefits and the problems they bring. We have studied about natural hazards and some ways to mitigate them. We can strive to learn more and publicize what we know. We can make the world a better place.

There is no doubt that the Earthquake of 2072 B.S. (2015) gave rise to a mass awareness about how that particular earthquake occurred. Some people used to say, with much politicisation, "There are two plates: Indian and Chinese. The Indian plate moves to the North to encroach the Chinese plate. Nepal is in middle. That was why the earthquake occurred."

While I myself tried to remove politics whenever I could, there is a mass of people who believe the above statement to be true. They are right that Nepal lies in between two plates. But most of them are not aware what "plate" really is and that the Earth's lithosphere is made of a number of plates. As a student of Geology, I feel that we have a lot to do to make the public aware of what the plates are and how they are formed.

We, ourselves however should be ready to face skepticism. Science is not a belief system. Whenever scientists come across hypotheses and theories, they first question, "Is it true? What are the evidences?" A hypothesis can become a major theory if evidences support it. The theory of Plate Tectonics is a common example. If the evidences from submarine navigation and Paleomagnetic studies had not been available, the theory would still have remained a hypothesis. Similarly, if a new hypothesis can challenge and prove that it is stronger than an existing theory, the existing theory, even if popular, will be discarded.

In short, as a student of science, I appeal to everyone to gain right knowledge from the nature, from each other and from what our ancestors have passed on to us. I urge everyone to deliver the knowledge to the public and to the generations to come. Because only with the right knowledge, we the make the world a better place.

Ankit Dhakal
Chief Editor
Geoworld, Vol.8, 2017

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SECTION A: GEOLOGY, ITS SCOPE AND RELATION WITH HUMANS

This section consists of scientific articles related to:

- Geology and its scopes
- Geology in Everyday Life
- Natural Hazards, Disasters and Mitigation

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EMPLOYMENT OPPORTUNITIES FOR A GEOLOGIST

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Abstract

Geology is an earth science comprising the study of solid Earth, the rocks of which it is composed, and the processes by which they change. Geology can also refer generally to the study of the solid features of any celestial body (such as the geology of the Moon or Mars). Geology gives insight into the history of the Earth by providing the primary evidence for plate tectonics, the evolutionary history of life, and past climates. It is important for mineral and hydrocarbon exploration and exploitation, evaluating water resources, understanding of natural hazards, the remediation of environmental problems, and for providing insights into past climate change. It also plays a role in geotechnical engineering and is a major academic discipline.

Key Words: *geology, geologist, scope, branches, importance and employment of geologist*

1. BACKGROUND

The term "Geology" is derived from two Ancient Greek words geo meaning earth and logos meaning study of or discourse. Hence, geology is the study of the planet earth. The earth science is concerned with the solid earth, rocks of which it is composed, and the process by which they change over the time. Geology also focuses on all the processes that happen on the earth, naturally and manmade. These activities are erosion, earthquake, volcanoes, and landslides as well long term evolution of earth's atmosphere, surface and life. Of course, geologic hazards are simply natural processes and becomes hazards only when people try to live where these process occur.

Understanding geology of an area is very important for sustainable development of infrastructures, economics and the sources of energy and natural resources. The sustainable development only can proceed having the knowledge of geology. Similarly, the knowledge of geology/earth science/geosciences is very important from the point of view of economics and aesthetics. Economically, the utilization of natural resources such as oil and gas, radioactive elements, ores and the minerals have great importance in which they are raw material for industrial use, and aesthetically millions of people attracted on gems, jewelry, and collection for national museum to private work.

2. OBJECTIVES

The main objectives of this article are:

- To learn about Geology and the branches of Geology
- To know about the scope of Geology and the importance of Geology
- The employment in the field of Geology

3. METHODOLOGY

This article is prepared based on only desk study of secondary sources of data from different books, literature, report, article and websites of related subject matter.

4. DISCUSSION

Geology is a multi-disciplinary subject that includes the study of minerals, rocks, structure of the earth, volcanic phenomena, and development of Sedimentary strata, landforms and the phenomenon that produce them, study of fossils, and evolution of the planet.

People who study the composition, structure and other physical aspects of earth are known as geologists, also known as geoscientists. They study earth's geologic past and present by using sophisticated instruments to analyze the composition of various materials. Many geoscientists help search for natural resources such as groundwater, metals, and petroleum. Others work closely with environmental and other scientist to preserve and clean up the environment. Many geoscientists spend the majority of their time in an office and laboratory work.

For a geoscientist, there are three degrees namely bachelors' degree (entry level), master degree (entry level, research position) and Ph.D. (high level research) respectively.

Branches of Geology

Traditionally, there are two broad areas of geology: Physical Geology and Historical Geology. To study the earth in detail, the subject of Geology has been divided into various branches:

1. **Physical Geology:** It is the branch of geology and deals with the various processes of physical agents such as wind, water, glaciers and sea waves, run on these agents go on modifying the surface of the earth continuously. Physical geology includes the study of Erosion, Transportation and Deposition (ETD).
2. **Crystallography:** A branch of geology deals with the study of crystals. A crystal is a regular polyhedral form bounded by smooth surfaces.
3. **Mineralogy:** A branch of geology deals with the study of minerals. A mineral may be defined as a naturally occurring, homogeneous solid, inorganically formed, having a definite chemical composition and ordered atomic arrangement.
4. **Petrology:** A branch of geology deals with the study of rocks. A rock is defined as the aggregation of minerals found in the earth's crust.
5. **Structural Geology:** A branch of geology deals with the study of structures found in rocks. It is also known as tectonic geology or simply tectonics. Structural geology is an arrangement of rocks.
6. **Stratigraphy:** A branch of geology deals with the study of stratified rocks and their correlation.
7. **Paleontology:** A branch of geology deals with the study of fossils and the ancient remains of plants and animals are referred to as fossils. Fossils are useful in the study of evolution and migration of animals and plants through ages, ancient geography and climate of an area.
8. **Historical Geology:** A branch of geology, it includes the study of both stratigraphy and paleontology. Its use in civil engineering is to know about the land and seas, the climate and the life of early times upon the earth.
9. **Economic Geology:** A branch of Geology deals with the study of minerals, rocks and materials of

economic importance like coal and petroleum.

10. **Mining Geology:** A branch of geology deals with the study of application of geology to mining engineering in such a way that the selection of suitable sites for quarrying and mines can be determined.
11. **Hydrology:** A branch of geology deals with the studies of both quality and quantity of water that are present in the rocks in different states i.e. conditions. Moreover, it includes: Atmospheric water, Surface water, and Underground water.
12. **Resources Engineering:** A branch of geology deals with the study of water, land, solar energy; minerals, forests, etc. that fulfill the human wants.
13. **Photogeology:** A branch of geology deals with the study of aerial photographs.
14. **Geomorphology:** It is an interaction between Geology and Hydrology.
15. **Engineering Geology:** It deals with the application of geology knowledge in the field of engineering for the construction of dams, bridge, tunnels, building, roads etc.
16. **Geophysics:** A branch of science, it is related with geology in such a way that it concerns with the constitution of the earth and the nature of the physical forces operating on within the earth.
17. **Geochemistry:** A branch of science deals with geology in such a way that it concerns with the abundance and distribution of various elements and compounds in the earth.

Scope and Employment Opportunities

As geology is technical subject, it is based on both theoretical and practical knowledge among them, field work important part of it. Also after completion of bachelor's degree in geology, then door opens for entry level of different projects that may be either governmental or private sector. Since geology has both applied and pure geology in under graduates to Ph.D. level, a geologist can choose his field according to study background. It can also be noted that it has branches and can be engaged after the qualification in the respective field in the world as the demand of geoscientist is increasing day by day mainly on under developing countries for example Nepal. Therefore, a well-established interdisciplinary branch of Science and Engineering has a scope in different fields as engineering geologist, geotechnical engineer i.e. in Civil Engineering, Mining Engineering, Ground Water and Sedimentology.

Activities of Geologist

Geoscientists analyze microscopically from past to present and to the future condition in both laboratory for in preparing thin sections or preparing maps, and field and gives the environmental, sustainable best results to the project managers.

Importance of Geology

- Geology provides a systematic knowledge of construction materials and their structure and properties. It is significant in locating water supplies, building and highway placement and mineral resources such as gravel, stone, oil and mineral deposits.
- The knowledge of groundwater, Geology is necessary in connection with excavation works, water supply irrigation and many other purposes.
- Knowledge about the nature of the rock and mineral properties is very necessary in tunneling, construction

roads and in determining the stability of cuts and slopes.

- The foundation problems of dams, bridges and buildings are directly related with geology of the area where they are to be built.
- The knowledge of Erosion, Landslide Transportation and Deposition by surface water helps in soil conservation, river control, coastal and harbor works.
- It is developing predictive models for earthquake, volcano eruption and tsunami activity.
- Understanding the development of life on earth is done by Geology.
- Geology provides fundamental knowledge to the field of earth and planetary sciences, determining planetary histories.
- Geological maps and sections help considerably in planning many engineering projects.
- Geological features like faults, joints, beds, folds solution channels are suitably treated to increase stability of the structure.

5. CONCLUSION

The study of geology mainly concerns itself with the study of earth‘s origin, structure, composition and history, and the nature of the processes. Geologists contribute their part to the nation through the discovery of new deposits of rocks and minerals of economic value.

Geological field trip is one of the most important parts of geology. Field sites are ideal places to observe different types of landforms, mineral, rocks and geological structures. Without geology and its application the developments will be body without life and ultimately it can uplift the life style and economic state of any nation by exploiting natural resources such as gas and oil, liquid gold/water, construction materials. Also the knowledge of geology can save many lives of people where the natural disasters prone.

ACKNOWLEDGEMENT

I would like to express my gratitude to Dr. Tara Nidhi Bhattarai for the opportunity and inspiration to write this article. I would also like to thank the editorial board for their suggestion and comments. Special thanks to all the Teachers and colleagues for their support directly and indirectly.

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Year of admission: **2070**

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Born in Jilla Aspatal, Udayapur, I grew in Triyuga Nagarpalika-06, Khaijanpur, Udayapur. I have completed school from Shree Janak Madhyamik Vidyalaya, Khaijanpur and 10 +2 from Advanced Academy Higher Secondary School, Kupandol, Lalitpur. My well-wishers urge me to be a good doctor and waited a year. As time passes I got another option to join class in Tri-Chandra Multiple Campus and attain the entrance examination. In Tri- Chandra Campus, I got admission in CBZ combination and attain all the lectures of the college in the beginning time. Among them the department of geology attracted me and brought revolution my thought that if all the science students became doctor then who will be an engineer, professor, scientist or businessman, et cetera and finally I changed the subject combination from CBZ to GBZ. Also, the subject geology was totally new for me.

In the first year of B.Sc., I enjoyed the course as it was all about the historical geology, paleontology and mineralogy. Among them, the tectonic activity such as earthquake, field work and practical class attracted me. I read the book entitled "Soch" written by Karna Shakya in which the writer focused on the thinking way of Nepalese people and how can we see the things with positive point of view. In other words, he discusses the perspectives of positive thinking and its roles in our daily lives.

In the same way, the second year of B. Sc., I learnt about petrology, Structural geology and Sedimentology. Bowmen series reaction and the process of metamorphism are the most impressing to me. As pressure, temperature and the surroundings play important role in metamorphism from which one material changed to another. These events occur in all the things and hence it happens within me. The field works inspire me to visit places with my friends as it teaches huge lessons.

Tri- Chandra Campus is popular for politics. Being a student of this campus, I got golden chance to learn politics in the form of knowledge in caste based nonpolitical organization namely Tharu Students' Society.

In the course of B. Sc. 3rd year geology, the geology of Nepal Himalaya and economic mineral deposits greatly impressed. These courses broaden my minds saying that "anektama ekta". It taught me the nationalism. Bruce Lee says, "Knowing is not enough, we must apply. Willing is not enough, we must do." I trust more in work than talk.

Currently I am studying B.Sc. 4th year with Geology Major. I am determined to be a good geologist in near future and serve my nation.

Geoworld, Vol. 8, 2017, pp. 6-8

AGROGEOLOGY

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Abstract

Agrogeology, a less familiar term is indeed a part of geology. Peter Van Straaten simplified agrogeology as "geology for the service of the Agriculture". Though agriculture and geology are vastly different and independent topic on their own they are somehow related and this relation gives the birth of new topic "Agrogeology". Soil formed by the decomposition and disintegration of the rock is the part of the land where crops can be planted. The soil is the source of the nutrition needed for crops to grow. If you feed the soil, that feeds the crops. Hence the main aspect of agrogeology is to maintain and enhance the productivity of the soil for increased social, economic and environmental benefits by beneficial application of rocks and minerals. This article defines the agrogeology, defines the relationship between geology and agriculture, a brief history of agrogeology and its importance.

Keywords: *agrogeology, agriculture, geology, agro-minerals*

1. INTRODUCTION

Agrogeology is a subdiscipline of geology is the scientific study of the origin, nature, composition, distribution and utilization of the soils for agriculture from the geological point of view. Geology, basically a scientific study of the Earth defines soil as the uppermost layer of the substratum. Agriculture, commonly known as farming is the cultivation of plants animal and fungi for food. Agriculture is directly related to the land and soil and the quality of the land and soil depend on the climate, environment, topography and geomorphology of the area. The geological process influences the distribution and formation of the soil. The trans-disciplinary approach combines the knowledge of soil scientists and farmers with that of geologists and process engineers.

Agrogeology also includes the study of the origin of the minerals known as the agrominerals and their applications. These minerals enhance the quality of the soil fertility. The soil is the source of the nutrients needed for crops to grow. But the quality of the soil is degrading day by day which leads to the less production of the crop. It is due to the loss of nutrients from the soil. For the agriculture to be sustainable the import of the nutrients in soil must match or exceed the loss of nutrients. To improve the effectiveness of sustainable soil quality, the option of using locally available geological nutrients resources must be activated.

2. HISTORY OF AGROGEOLOGY

Agrogeology first rose to prominence in the 19th century when scientists realized the potential of the natural minerals to fertilize the soils. The first agrogeological conference held in 1910 settled several issues including settling of the term "Agrogeology". The study of agrogeology

continued as the branch of the geology in the early 20th century and later it was more associated with soil science and agronomy. Agrogeology was found to be more intriguing after 1970 with the work of researchers like the late professors William Fyfe, Ward Chesworth and Peter Van Straaten. They use their knowledge and experience of geology in the field of scientific or modern agriculture. They used their geological expertise to assist agriculture in different nations. Peter Van Straaten worked in Africa to identify different sources of minerals for remineralization in the region. He has helped to prove that turning rocks into fertilizers can be socially and economically viable. This leads to the evolution of the modern agrogeology.

3. IMPORTANCE OF AGROGEOLOGY

Peter Van Straaten simplified agrogeology as the geology for the service of agriculture. Geologists really have got vital duty to serve agriculture. So the agrogeology uses the principles and applications of geology for the betterment of agriculture. The most important tasks of agrogeology area as follows

i) Investigation of the geological factors of different soil degradation processes such as erosion, deflation, salinization, acidification, desiccation, etc. prediction of the occurrence of these processes together with the geological chances of their prevention and minimization.

ii) Detailed agrogeological description and specification of farmlands and land units aimed at optimal land use as well as supporting the rational selection of crops and the production system.

iii) Examination of the agrogeological and water regime properties of the soil, soil forming sediment and parent rock for the groundwater system characteristic for the given land unit.

iv) Researching and predicting the real soil forming sequence

v) Investigation of the possible risk of natural calamities like flood, landslide etc. on agricultural land and its solution. Investigation and coordination of geological aspect of water regulation and irrigation.

vi) Examine how soil nutrients, pH and soil structure can be improved using naturally occurring mineral-rich rock materials. Rocks such as potash, gypsum, limestone and dolomites are rich in nutrients and can be used as fertilizers. It helps in identifying, mapping, and utilizing phosphate rich rocks in order to increase phosphate in the soil. Rocks such as limestone and dolomite can be used to reduce the acidity of the soil and to increase the pH.

4. CONCLUSION

Geology has a wide range of scope. It has been the part of people's life directly or indirectly. Geology has contributed in many sectors and agriculture is one of it. With the introduction of a scientific or technical way of farming the production of agriculture is supposed to be increasing and sustainable agriculture is fundamental to global development. Food security is the emerging problem and to overcome the problem geology has contributed in the agricultural sector. Agrogeology is introduced to make strategies to overcome soil productivity decline with geological or mineral based

material to improve the quality of the soil. Hence agrogeology is very important. Since it is closely related to the most basic need of a living thing. Agrogeology has also social, economic and environmental benefits.

ACKNOWLEDGEMENT

I would like to acknowledge with the sincerest gratitude to Professor Dr Tara Nidhi Bhattarai for his guidance and encouragement. I would like to express my sincerest thanks to the Department of Geology and all our revered teachers.

Special thanks to Mr Ankit Dhakal, the chief editor of Geoworld 2017 and his team. I am very thankful to Mr Anil Regmi and Sanjaya GC for their help and guidance.

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About the Author of *Agrogeology*

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Combination: Geology, Physics and Mathematics

Born in Jalajala- 2 Mallaj, Parbat. I passed my S.L.C examination from Amrit Adarsha Secondary Boarding school, Jaljala-3 Mallaj, Parbat and intermediate(+2) (science physical group) from Pentagon International College, Tinkune Kathmandu I admitted Tri-Chandra Multiple College morning shift with the combination Geology, Physics and Mathematics (GPM).

I really didn't know about geology at all. I had to fill the form with three major subjects and I chose Geology as one of them. But later I found this subject the most intriguing subject. I really enjoyed it and decided to pursue my career on it. The Department of Geology was the most managed department of the college. I am very glad that I took the very right decision unknowingly. Geology is best learnt in the field. It is a practical based subject and for a person likes me who enjoys travelling these geological fields were complete paradise-- Learning while travelling and travelling while learning. I must say those were the best days of my life.

This subject taught me not only the geology but also the discipline and punctuality. I am not a gregarious person but taught me working on group and leading the group. I feel privileged that I am the part this historical college with 100 long years of service.

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GEOLOGY: THE HIDDEN SUBJECT

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ABSTRACT

This paper aims to understand the amount of geology needed in the day to day life. Despite being vulnerable to various geo-hazards, Nepal does not seem to have progressive thinking on geo-science and geo-hazards. The Gorkha Earthquake 2017 has causes huge destruction both in terms of lives and property. This huge destruction during earthquake proves that Nepal really is poor countries in developing knowledge in geological process, preparedness and awareness. Nepal ranks within top 20 of the multi-hazard prone countries in the world. Every year the people of Nepal are compelled to lose their lives and property without any reason. So it the responsibilities of the government to maintain keep its population in geologic safe place and in some case provide geologic awareness to protect themselves from natural hazards.

1. BACKGROUND

Geology being a fascinating subject, its importance and scope has not been well developed in the countries like Nepal. Some other countries like USA, Japan, and China etc. have developed much more interest and great contribution in the geology. Our country Nepal is lagging behind in the geological development work because geology is taken as a secondary subject rather than other. We must not forget that geology is the major foundation of every infrastructure. Though, Kathmandu being capital city has not developed clear concept on geology how could the nooks and corner of this country will understand the geology. Geology has become the hidden subject among all the people. We built the houses, construct bridge and road but we do not care on the geological condition and its possible consequences which is necessary during construction. So the geology subject must come on to the light as a major subject because our life is possible only when we feel ourselves safe from all the natural disasters as it encompasses the history, morphology, natural hazards, mineralogy and relationship between human and natural hazards.

2. OBJECTIVES

Nepal being land locked country and lying in highly tectonic active zone, uncountable natural hazards occur in a second. Due to this reason this country is also known as the country of natural hazards. So the people of this country must be aware of geological phenomena in and around the area. The main objectives of this paper are:

- To raise the geological awareness about the importance of geology in our day to day life.

- To enlighten the geology as a major source of education.
- To minimize the natural hazards and its risks and vulnerability.
- To encourage the people to establish the mutual relationship between environment and infrastructure.

3. METHODOLOGY

The survey taken in Dhading Besi for the collection of data was helpful for this article. Further some books, journals, newspaper were studied. Internet was used as best method and owns logic during survey was the methods used in the field.

4. FIELD INVESTIGATION AND DATA COLLECTION

Nepal being highly active tectonic zone, suffers a lot from the natural hazards. Every year the people from Hills and Mountains suffer from landslides and the people from Terai suffer from floods. Nepal is the 14th most in natural hazard prone country in the world, but the public is unaware of the reasons and consequences of natural hazards. Government of Nepal has not taken any action to overcome those natural hazards. It does not have complete solution for this and neither it has encouraged/ provided basic knowledge of geology to the country men. Because of the lack of knowledge or we say ignorance of geology, Nepal has recently faced a great challenge both in terms of lives as well as property on April 2072. A huge earthquake 7.8 mw on April 2015 has caused huge destruction both in terms of lives and property. About 9,000 people were dead and thousands of houses were fully destroyed and has huge destruction of property. On the one hand, Nepal is tectonic active country. On the other hand, there is no geologic awareness among the people. Dhading is one of the 14 most affected districts from the 2015-Gorkha earthquake Nepal. The survey taken in Dhading Besi on topic "Importance of Basic Geological Education" (SIT, 2017) has proven that there is lack of geological knowledge.

5. RESULT AND DISSCUSSION

The survey taken in Dhading Besi on the topic "Importance of Basic Geological Education" (SIT, 2017) helped to find out the relationship between the geo-science and geo-hazards. From this survey the need of geologic awareness is prime important. Based on the data, we observed that people feel the urge to educate their children or even themselves from school or high school or from geologic awareness program. More than 90% of people don't know geologic process, causes of natural hazards and preparedness during the geo-hazards. This is due to that the geology being the hidden subject.

6. CONCLUSION

From the above result, it has been concluded that in context of Nepal, the subject Geology has become the hidden subject, due to which the people of this country are facing a lot of geological problems. So the government of Nepal must take all these in consideration and should have new subject (Geology) in curriculum of school and high school level in order to improve the quality of life of countrymen. In addition to this, Nepal needs a good national policy, acts and strategy and effective implementation of these instruments to deal with the regularly occurring disasters such as earthquake, landslides and floods.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to our respected sir Dr. Tara Nidhi Bhattarai to encourage and motivating the students to show their talents in writing in the form of article. I also like to thank all those who contribute me by helping a lot during the preparation of article.

Furthermore, I would like give my special thanks to my friends who are in the editorial board helping me pointing out my mistakes and correcting my language and improved me in writing power.

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About the Author of *Geology: The Hidden Subject*

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Sarlahi being under developed district although stands at top position in agriculture, specially sugarcane production and hot climate zone in the country where I was born. I completed my secondary level education from Moon Light Secondary School in Sarlahi district. After completion of my secondary level education, carrying a new enthusiasm and dreams of my life, I headed my journey towards Kathmandu to complete my higher secondary level education and got admitted in Jubilant College. After completion of higher secondary education, I was hovering and wondering about my future life. Selection of subject for further education was one of the challenges to me. But by that situation, my sister Pramila Pokharel suggested me to join geology in Tri-Chandra College. She inspired me to join this subject and got admitted in Tri-Chandra as a geology student. After understanding the language of geology, my interest towards geology had increased a lot and it keeps increasing in near future.

I have gone through many books. All those books have inspired me a lot but one of my favorite books is “Seto Dharti” by Amar Neupane. The book is all about a struggle faced by a girl whose husband died at early age and about the pity Nepali culture and tradition at old age.

Being the student of Tri-Chandra College, it was a challenge for me because I had never seen such crowded population before in my life. At first it was very challenging. By the time later I was adapted in that environment. The fields in the Malekhu and Palpa, Tansen are the memories of the geology that never get deleted. Despite of the positive aspect of geology, there are other many negative aspect is that there is still no rules and regulations in the class and no rules for teacher as well.

My interest is creating new things in my mind; enjoy reading novel, books and making new friends and listening to music. I believe on myself that I will become skilled and professional geologist within 10 years because of my hard working, belief and confidence.

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IGNORANCE OF GEOLOGY IN NEPAL

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Abstract

Nepal ranks within top 20 of the multi-hazard prone countries in the world. It is 4th, 11th and 30th most risky in terms of climate change, earthquake and flood respectively. Every year hundreds of lives are destroyed and thousands are placed in danger. Despite the risks of geological hazards in Nepal, even the government is not serious enough to work upon them. It is sometimes believed that "Ignorance is bliss" but ignoring geology can be more fatal. This paper aims to contribute to the importance of geology and put some light on the adverse lights on ignorance of it.

1. Background

Our country Nepal covers only an area of 147,181 sq. km. but includes a variety of morphological, physical, geographical and geological features within it. The distinction in these features comes from the distinction in their size, shape, strength and overall appearance. The study of earth along with all its above- mentioned features is simply defined as geology. According to the Oxford Dictionary, "Geology is the science which deals with the physical structure and substance of the earth, their history, and the processes which act on them." Geology is considered to be very important for the better understanding of the ongoing processes and its effects on earth. Designs, construction processes, the stability of land, slopes and vulnerability to natural hazards can be studied and observed by geological methods. The main problem in the current time is the ignorance of geology which is responsible for the disastrous events taking place.

2. Objectives

Ignorance of geology can be considered as a burning issue in this modern Nepal. A lot of works which should be performed under the supervision of a professional geologist are carried out without them. So, this paper aims the following:

- To raise awareness about the importance of geology in our day-to-day activities.
- To increase manpower (skilled, semi-skilled and non-skilled) who can contribute in the field of geology.
- To minimize the vulnerability of any place or area to natural hazards.
- To prevent the loss of natural or man- made structures and sometimes, even life.
- To manage every construction processes (dams, bridges, buildings,

monuments, roads) effectively and efficiently.
- To balance nature and development in most possible ways.

3. Methodology

Soon after the selection of the topic for the paper, various methods for the study were applied. Internet surfing was proved very helpful in this. Some books, journals, newspapers were studied. Lectures attended in college also helped to broaden our minds on the relevant topic.

4. Field Investigation & Data Collection

Although Nepal has been listed as a very risky zone in the case of natural geological hazards, very few measures have been applied in the control of them. We can always see the ignorance of geology in the things going on around us and have also experienced the loss resulting from them. Still, it is a surprise that people are not paying enough attention to geology as it deserves. Some of the illustrations covering the ignorance of geology and the loss from it are as follows:

- **Nepal Earthquake 2015:** The most recent disastrous earthquake, with a magnitude of 7.8 Mw on 25th April 2015 killing nearly 9,000 people injuring nearly 22,000 people and making 3.5 million of people homeless could not be predicted and cured but can be prevented only if the geological issues are given utmost importance which they deserve. Proper management of infrastructures according to the geological features of the area on which they reside can undoubtedly decrease the loss of property and even human life.
- **B.P. Highway,** constructed with a Japanese grant of 21.5 billion was considered to be an example for engineering. It came as a huge shock when a section of the road collapsed at Trivenighat above Sunkoshi River. The main reasons are believed to be an inadequate measure post-2015 earthquake in the difficult terrain and poor traffic management. Any infrastructure constructed has its bearing capacity which when exceeded can collapse. After a powerful earthquake, terrains become risky. So, they should be taken care of but the ignorance of geological issues resulted in the failure of the road. (Kathmandu Post, 21-02-2017)

Figure 1 The collapsing of a section of B.P. Highway. Image source: www.nagariknews.com

- **Landslide** blocking the Sunkoshi river in August 2014 occurred in Jure, Sindhupalchowk killing 156 people. This place had previously been warned but due to the ignorance of the responsible people, it resulted in a disaster.
- **Recurring landslides** in the Siddhababa section of the Siddhartha Highway have always been in the eyes of geologists and government too. It has caused the loss of lives from time to time. Despite this, seriousness has been rising in the case of Siddhababa nowadays and it will certainly result in stable hills and life.
- Lastly, **Japan** is the most prone country to earthquakes and after tsunamis but we need to keep the fact in mind that it is also the most prepared country for natural geological hazards. They can face it with minimum loss. The individuals, as well as the government, are prepared enough by the awareness, emergency kits, geological design of structures and the strength. So, Japan can be taken as an example that the proper geological design and awareness on geological issues will contribute a lot in nation's safety.

5. RESULTS & DISCUSSION

Natural disasters occur as the rule of nature. So, no human is powerful enough to predict, stop and save the earth from their catastrophic effects. The maximum we can do to minimize it is to accept it and walk hand in hand so that it minimizes effects. From above illustrations, it can be clear that geology is by far the best tool to understand the mechanism of natural disasters and be safe afterwards. Geology can help us to know the stability and durability of any land on earth or any infrastructures residing on earth. The designs of any structures should be done in a way that it suits its land type and its stability. The risks can be realized and even calculated with the proper knowledge of geology. So, as people say "Prevention is better than cure", one should always be aware and prepared enough to face geological hazards as their complete cure is impossible.

6. CONCLUSIONS:

Natural disasters and geology are weighty yet very important issues affecting huge mass mostly a whole country and even more. So, the joint efforts of individual and government should be always encouraged. The government is the most powerful organization in the country which can formulate any rules and policies and can also discard them. So, the government should formulate some strong laws and policies in the favour of geology. Ignorance in terms of geology should be discarded. Awareness on the geological issues and the loss resulted if ignored should be raised by the use of social media, newspapers, magazines, journals and so on. The advertisement is the best medium to raise awareness in this modern digital world. A geologist's advice should be always included in any small or large project. Frequent survey and investigation should be performed. Geology should be included from the school level and high-school level so that even the children “are aware enough to face natural disasters”. Encouragement should be given to the people who are contributing in the fields of geology to make our nation a safe one. Proper recognition and felicitation of geology and geologists will also encourage geologists to work more efficiently. Each risk zone should be treated differently according to the hazards.

Preventive measures should be applied to be safe from it. If only these measures are applied in practical life, it will undoubtedly result in a safer Nepal.

ACKNOWLEDGEMENT

I would like to express my thanks to the Department of Geology and our teachers for encouraging us to make this magazine "GEO WORLD" from the creative and knowledgeable efforts by all the students. I would also like to thank my friends who are working as editors to make our articles better. Furthermore, I would also like to thank our respected teacher, Tara Nidhi Bhattarai for giving time and making efforts for us.

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About the Author of *Ignorance of Geology in Nepal*

Year of Admission: 2070

Name: Nirusha Shrestha

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Dhading sometimes considered being the darkness below a burning candle in reference to the closeness to the capital city and yet underdeveloped is where I was born. I attended Dhading Boarding Higher Secondary School till I completed my school level and passed S.L.C. The absence of science colleges in my place compelled me to travel in the capital city and completed my intermediate level in Nepal Mega College situated in Babar Mahal, Kathmandu. After the completion of my intermediate level, I was too confused about my future like any other students. Meanwhile, my cousin brother suggested me about geology and without the proper knowledge what geology was all about, I decided to read geology in my Bachelors' level. My instant decision made right at that time helped me explore my interests and strengths in life.

I always have been attracted by books in my life. Books point out new perspectives about certain things in life. A lot of books have inspired me in their own way. Among them, 'Palpasa Cafe' by Narayan Wagle, 'The Kite Runner' by Khaled Hosseini and other books of Bangladeshi writer Taslima Nasreen are some of my favourites. They have emotionally touched my soul and heart and always inspire me to be a better person in life.

Although I was unaware of the subject at the beginning, I gradually started developing interests in it. These four years have been an interesting period in my life which will be forever cherished. The times we spent together in our field visits as a family were the precious memories I have been left with. The knowledge along with the emotional support and cooperation provided by our teachers are the blessings that will undoubtedly remain in the heart of every student.

Reading books, watching movies, experiencing new adventures, making friends and travelling have always been on my to-do list.

I dream to be a responsible and sensible person contributing to the nation as a professional geologist in future.

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MINERAL RESOURCES OF NEPAL

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Abstract

This paper comprises about the location of natural resources found in Nepal. Due to complex geology and rugged topography, there are lots of challenges for the exploration of these mineral resources. However, some metallic and nonmetallic minerals have been extracted in different parts of the country. This article has also elaborated about sustainable development of this mineral resources and the ways for the mitigating the ongoing challenges.

Key Words: Mineral resources, Mining, Exploration, Current status, Challenges

1. BACKGROUND

The prosperity in natural resources and their proper utilization makes a country rich. Mineral resources of Nepal are technically and economically in feasible condition for their extraction and utilization. They are extracted from their respected ores. From the southern part of Nepal i.e. Terai to the northern part of Nepal i.e. mountainous region, we can find various minerals scattering in their original position. Detail geological map of the entire country is essential to understand the different geological features of the country. This will help for detail investigation of various belts for particular aspects such as mineral exploration and its investigation. Statistical analysis of such information will lead to exploring some virgin area. Different countries like United States, India and their collaboration has launched various exploration programs to explore various potential minerals of Nepal. However, a very effective, systematic, scientific geological survey and mineral exploration work were conducted in the last two decades (DMG, 1993), by the department which has resulted in some major achievement for the economic growth of the nation. DMG has provided 590 prospecting licenses for the exploration of 27 minerals and 104 mining license for mining 14 mineral commodities in different parts of the country in the fiscal year 2012/13. We can observe most of the entrepreneurs are interested in the exploration of non-metallic mineral i.e. limestone. However, the allocation of mining license has been balanced regionally. Minerals exploration was rapid during 1974-1980 (DMG, 2004).

2. OBJECTIVES

- To show location and availability of natural resources in Nepal.
- To elaborate ongoing challenges for mineral resources development.
- To mitigate the related problems.

3. METHODOLOGY

All the information for the article was gathered from the secondary sources like books, websites, and online journals.

4. FIELD INVESTIGATION AND DATA COLLECTION

From the geological division of Nepal, the Indo-Gangetic plain has the possibility of petroleum and natural gas. Siwalik is rich in Eocene coals, petroleum, natural gases, construction materials and radioactive minerals. Similarly, lesser Himalaya is rich in various metallic and non-metallic minerals as well as coals and natural gases. Higher Himalaya is prosperous with various semi-precious and precious gem mineral, different metallic and non-metallic deposit with radioactive minerals and Tibetan Tethys Himalaya consists of various decorative stones, coals, natural gases and semi-precious gem mineral (DMG, 2017).

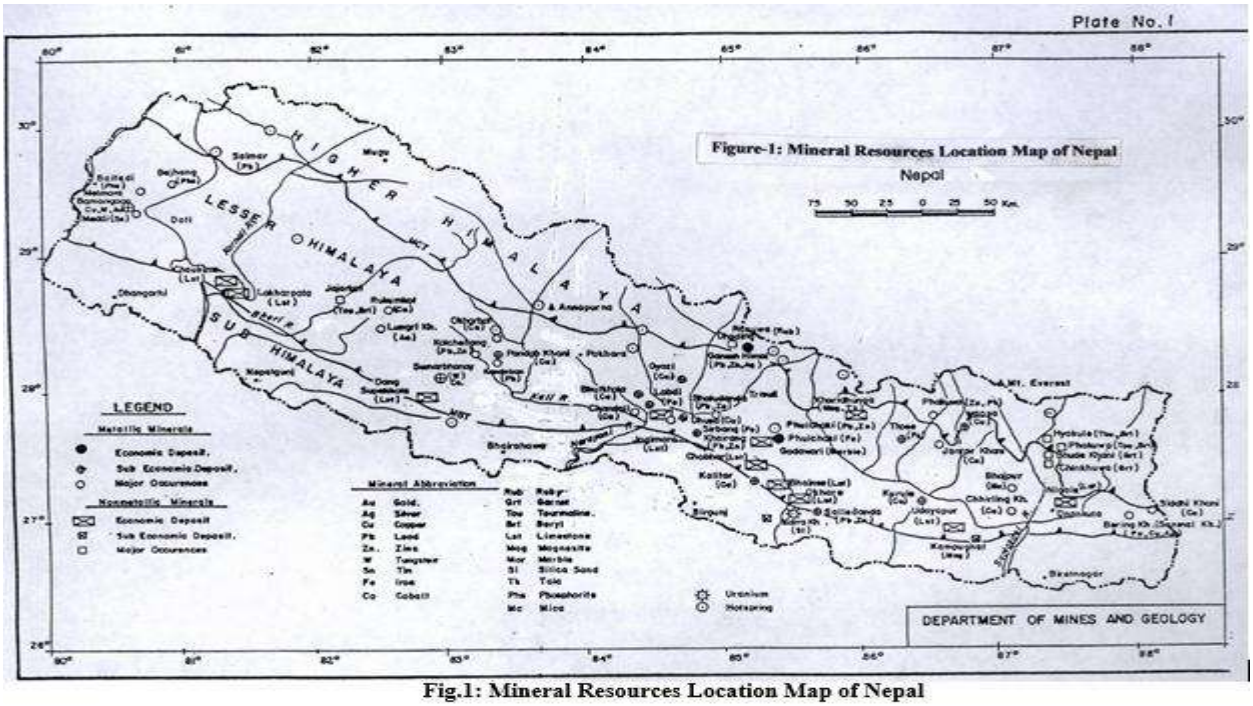

Fig.1: Mineral Resources Location Map of Nepal

are imported from other countries due to lack of exploration, investigation concept and resources. Similarly, lesser Himalaya has a prospect for metallic mineral mainly iron, copper, zinc, lead, cobalt, nickel, tin, tungsten, molybdenum, gold, uranium& rare metals. The small-scale copper mines were operated in Gyazi (Gorkha), Okharbot (Myagdi) and Wapsa (Solukhumbu). However, Makwanpur, Dhading, Baglung, Tanahu are prone for copper deposit. Occurrences of iron are reported from Phulchoki (Lalitpur), Those (Ramechhap), Jirbang (Chitawan). Among this deposit, Phulchoki iron of Lalitpur is found to be largest i.e. 10.67M Ton (DMG 2004). Lead mining in Nepal is reported mainly from

5. RESULT AND DISCUSSION

Almost 83% of Nepalese territory is mountainous. The mountainous region and geological environment are suitable for metallic, non-metallic (industrial, gemstone, energy fuel) mineral deposit. The southernmost Terai plain is potential for gravel, sand, groundwater, petroleum and natural gas. Gravel has been used for constructing purposes. The sub-Himalaya (Siwalik/Churia) is a potential area for construction materials, radioactive minerals, petroleum, natural gases and a minor amount of coal. However, the fuel minerals

Ganesh Himal (Rasuwa), Khairang (Makwanpur), Pangum (Solukhumbu) and Baglung district. Zinc mining is also reported from Ganesh Himal (Rasuwa), Pangum (Solukhumbu), Phulchoki (Lalitpur) and non-metallic minerals limestone, dolomite, talc, clay, Kaolin etc.; gemstone like tourmaline, aquamarine, beryl, garnet, kyanite, etc.; fuel minerals like coal, petroleum, methane gas, hot spring (Kaphle, 2014; DMG, 2004), are reported in this region. The area of higher Himalaya is highly promising for precious and semi-precious stone. Gem mineral aquamarine is reported from Naje, Manang, Hyakule and Phakuwa, Sankhuwasabha, Ikabu, Lodantar, Taplejung. Schist observed in Jajarkot and Sankhuwashaba show a significant amount of kyanite. Ruby and Sapphire found over here are considered one of the best qualities in the world. Tibetan Tethys is prospective for limestone, gypsum, and brine water. Limestone of varied qualities is found here. It occupies about 7,000 km^2 area of Nepal (Kaphle 2014).

The continuous geodynamic process in the Himalayan region results in many thrusting, folding, faulting and metamorphic effect in various part of the region. Similarly, due to rugged topography, almost all the area of higher Himalaya and Tibetan Tethys are unexplored. The inadequate infrastructure, due to poor economic condition of our country the exploration work is lacking behind. We don't have good facilities for roads, electricity and other necessary modern equipment for the exploration and exploitation of mineral resources available over here. The lack of technical manpower is also the main cause for ineffective utilization of these resources. Similarly, the inappropriate policy adopted by the government of Nepal for its preservation and conservation has been a great problem for development. These challenges are major hindrances for mineral resources development in the country.

6. CONCLUSION

Apart from being rich in mineral resources only few part of these resources are used for the development of the country. However, many parts are not investigated i.e. unexplored. For the sustainable development of this resources government of Nepal should be strictly involved for making proper policy. People around the country should be aware of its importance and proper utilization. Expansion of infrastructures, modern machine, equipment, technical skill to the people in the rural area must be broadened for the exploration of mineral resources. This will generate employment opportunity to the people around the area; as a result, the GDP of the nation will be increased. The entrepreneurs must be encouraged to conduct investigation and exploration, by supporting them in building infrastructures like road, transmission line and other facilities like tax exemption in importing machinery, etc.

ACKNOWLEDGEMENT

I would like to express my gratitude to Dr Tara Nidhi Bhattarai for providing me with a wonderful opportunity to write this article. I also can't stay patient without thanking my friend Bishal Maharjan who helped me in directing this article.

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About the Author of *Mineral Resources of Nepal*

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Subject combination: Geology, Botany, Zoology

I was born in Silonijan, Assam, India. In the year 2060, my family migrated to Bharatpur, Nepal. I passed SLC from Kalika Secondary English Boarding School. Likewise, I completed my +2 from Aroma College of Applied Science and Management, Bharatpur, Chitwan. Actually, I was totally unknown about geology. One of my friends suggested me and elaborated about the scope of geology. Then I decided to join Tri-Chandra Multiple Campus for Bachelor's in Geology.

When I started taking my class the lecture of my respected teacher was so impressive that my interest toward geology increase day by day. During my study period in the 2nd year, an enormous earthquake took place in our country. After that, the popularity of geology was flourished all over the nation. Although it was the serious problem for the people this disaster helped me to enhance my knowledge of geology. Then during my 3rd year, I was more serious towards my study. Finally, I decided to take geology as my major subject in the 4th year.

In coming ten years, I will prove myself one of the great geologists in Nepal.

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NATURAL GAS IN KATHMANDU VALLEY

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ABSTRACT

This article is about natural gas deposit (mainly Methane) in Kathmandu valley. Most of the people didn't know about the existence of natural gases in Kathmandu valley. People became more aware toward this due to internal and external political situation of Nepal during last few years. Since a long time, Nepal has been dependent on another country for fuel. There has been some investigation going on but the government of Nepal has not taken a strong effort on this issue. Nepal has gone through the fuel crisis various times throughout the period so natural gas deposit could hope until the government could find a stable source of energy that could lead to prosperous Nepal. The purpose of this is to find out the feasibility of natural gas in Kathmandu valley and its use as an alternative source of energy. An investigation was carried out by Japanese International Cooperation Agency (JICA) and many other which shows the viability of methane gas deposit in Kathmandu valley.

***Keywords**: Kathmandu, Natural gas, Energy source, Methane, viability*

1. BACKGROUND

Kathmandu valley is a bowl-shaped intramontane basin and surrounded by four main mountain ranges Shivapuri, Phulchoki, Nagarjun and Chandragiri. The Kathmandu valley lies in lesser Himalaya and has an average height of 1350m from mean sea level and area of 650km^2. The Kathmandu valley is composed of Quaternary fluvio-lacustrine deposit of Pre Cambrian- Devonian. The quaternary sediments are composed of mud, sand, gravel bed, and diatomaceous earth. The investigation carried out by JICA (1980) reported that natural gas is in existence in Kathmandu valley and is in the form of "dissolved in water type" (NGW) originated from the Quaternary fluvio-lacustrine sediments (Koji Motojima, Hiro's Natori, Shozo Nagata and Fuminori Takizawa).

Generally natural is a product of decomposed organic matter, typically from ancient marine microorganisms, deposited over the past 550 million years. This organic material got decomposed in buried environment for a long time and sealed off in an oxygen-free environment and exposed to increasing amounts of heat and pressure, the organic matter underwent a thermal breakdown process that converted it into hydrocarbons. The lightest of these hydrocarbons exist in the gaseous state under normal conditions and are known collectively as natural gas. In its pure form, natural gas is a colourless, odourless gas

composed primarily of methane. Methane, the simplest and lightest hydrocarbon, is a highly flammable compound consisting of one carbon atom surrounded by four hydrogen atoms (chemical formula: CH4).

Kathmandu valley consists of the sediments which are rich in organic matter and could become the source of marsh deposit and lacustrine deposits. This provides a suitable environment for the formation of the natural gas reservoir. Natural gas of "dissolved in water" is formed when a natural gas containing methane as the dominant component is dissolved in groundwater due to hydrostatic pressure. The pressure provided by suitable depth is another factor for natural gas deposit as gas volume dissolve rate of water is directly proportional to depth.

2. OBJECTIVES:

The main objectives are:

1. To study the depositional environment of natural gases

2. To determine the availability of natural gas deposit of Kathmandu

3. To estimate the natural gas reserve of Kathmandu valley

3. METHODOLOGY:

This article is based on the previously published report, articles and available secondary sources such as books, documents, published news, data from websites and the internet. Due to the limited time limit and resource, the field investigation is not included and the article is based on the previously published report, articles and books from different authors. Finally, all the collected materials were presented systematically in the form of an article.

4. DATA COLLECTION

The natural gas deposits of Kathmandu Valley have been studied by many national & International experts, the most prominent being Indian, Chinese & Japanese. Oil and Gas commission of India studied in 1964 and reported that the gas is confined to small sand lenses and not useful from an economic point of view. Similarly, a Chinese Petroleum investigation team made a study in 1973. They also reported that the deposit had no industrial importance. However, actual systematic exploration work was carried out by the Department of Mines and Geology from 1978. The exploration work was initiated in collaboration with JICA, the Japan International Cooperation Agency. The investigation executed by JICA was carried out in eighteen pre drilled well, having depth 20m to 330m from various locations. In order to confirm the deposit, an initial test well was drilled to a depth of 300 meters at Tripureshwor in 1980. The results obtained from the test well were quite encouraging. The average chemical composition of natural gases is as follows and location map of those well are as follows:

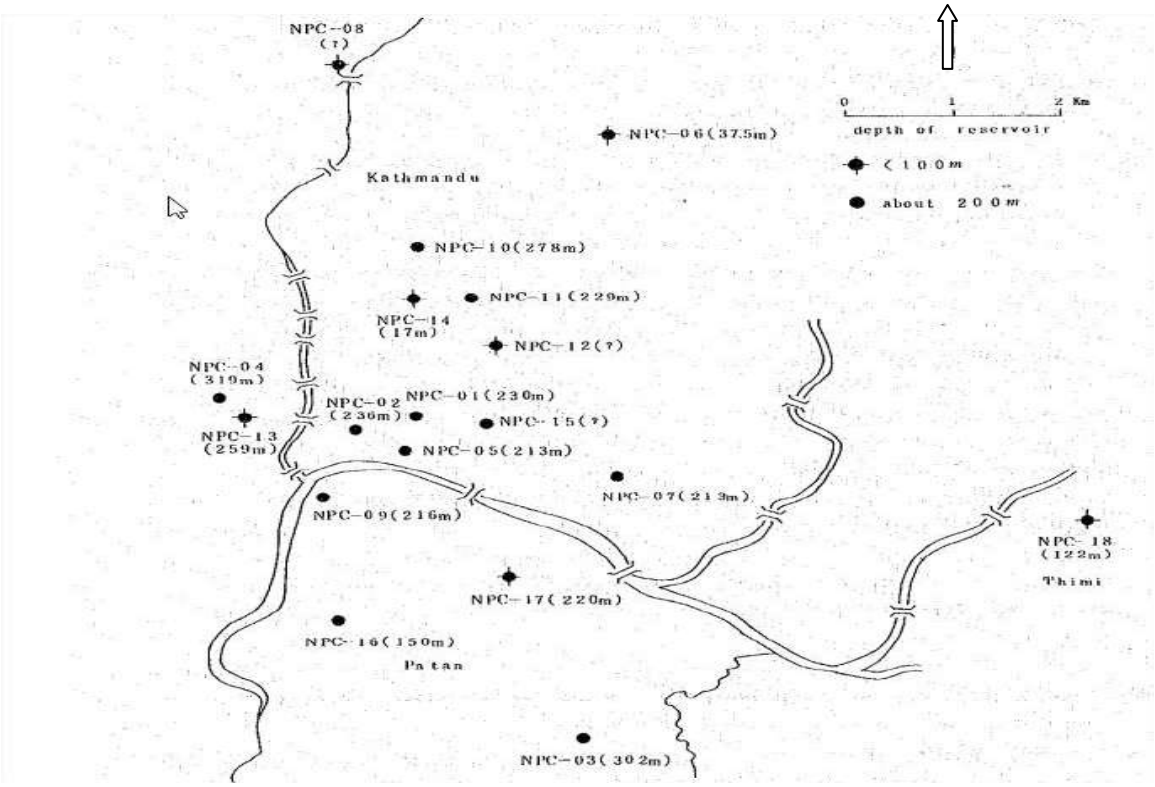

Figure 1: Location and depth of observed well (JICA, 1980)

Table 1: The chemical composition of natural gases JICA (1980)

Component of natural gases	Percentage
Methane	75 – 80%
Carbon dioxide	14 – 23 %
Nitrogen	1.5 – 6%
Oxygen	Less than 0.3%
Ethane	0.000 – 0.003%
Helium	0.012%
Hydrogen sulfide	0 – 20 ppm

5. RESULT AND DISCUSSION:

The natural gas is deposited in dissolved state with water. The data from borehole, resistivity and gravity data of an area about 26km^2 has been characterized as a prospective area with estimated reserve of about 300 million cubic meters. The gas reservoir can be divided into two groups according to the depth. The reservoirs having a depth less than 100m are classified in one group and reservoirs having the depth of about 200m are classified in other. The productivity of 200m depth reservoir is higher than that of shallow depth reservoirs. A pre-feasibility study has indicated that the estimated gas reserve of Kathmandu Valley if used, can meet the energy demand of 20,000 people for more than 50 years (JICA, 1980). It's been a long time since the investigation so government should think about formulating new investigation to pin point the current status of natural gas reserve of Kathmandu.

6. CONCLUSION

The investigation carried out by JICA suggests the presence of methane gas in dissolved state with water. The estimated reserve of methane gas is about 300 million cubic meters. The study concludes that the use of methane gas is viable for both domestic and industrial purposes. Nepal has been spending more than 40 billion just on petroleum products. This indicates the need of an alternative source of energy and that role of the alternative source of energy could be played by natural gas resources of Nepal. Thus the methane gas deposit of Kathmandu could be used as alternative source of energy. The use of natural gas present in Kathmandu valley could buy some time till a stable source of energy could be established.

ACKNOWLEDGEMENT

I am very grateful to Dr Tara Nidhi Bhattarai, for supporting us to write an article for publishing in the Geoworld magazine. I would like to extend my sincere gratitude to all the respected teachers of Tri-Chandra Multiple Campus, Department of Geology for their valuable help and suggestions. I would like to give special thanks to chief editor Ankit Dhakal for providing support.

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Government of Nepal National Planning Commission Secretariat Central Bureau of Statistics 2016

About the Author of *Natural Gas in Kathmandu Valley*

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Roll No: 785/70

Subject combination: Geology, Physics & Mathematics

I was born in Patan, Lalitpur. I did my schooling from TPVHSS. I completed my +2 from Campion Academy. As soon as I completed intermediate level, I thought that I would pursue my bachelor degree with physics as major. Later, I came to know about the subject that I never heard before and that is Geology. Later I started gathering information about the Geology subject from my senior's and friends. Finally, I joined Tri-Chandra campus taking Geology, Physics and Mathematics as a subject combination.

I was interested in physics. I have no certain intention to continue the geology for a long time but as soon as the session started I found geology is much more fascinating subject. This makes me able to view the things that we see every day in a different manner than normal people do. The classes are regular at geology department whereas other departments are just opposite in the case of the regularity of classes. Then I realize that geology is what I should pursue to complete my bachelor degree.

I am interested in music and sports. I like to read books in leisure time. I love to read the books based on reality rather than some fictitious or fabricated concerned literature. Besides that, I like to watch movies. I love to travel to new places. This might be one reason that I got attracted toward Geology. The fusion of these two elements made every journey meaningful and more engaging.

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PLATE TECTONICS

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Abstract
The earth is a dynamic planet. Every physical, chemical and biological elements are dynamic and always in the state of changing but at a different pace. The earth crust i.e. the uppermost physical part of the earth is in the state of deformation from the date of its formation. Even 50 years back from now there was a belief that the continents now present are permanently stationary. But the long term study and subsequent findings have discovered the idea that the continents and oceans are in continuous motion on the planet surface. Such crustal motion of the earth is known as plate tectonics caused by various external and internal phenomena.

Key Words: Continental drift, seafloor spreading, Pangea, Panthalassa, mid oceanic ridges, trenches

1. Background

The earth possesses three physical parts i.e. the crust, the mantle and the core. The crust is the uppermost part that is about 35 km thick of solid rock matter. Its thickness varies from 5 km in the oceanic region to 70-80 km in the mountainous region. The crust along with the uppermost layer of the mantle behaves as a strong rigid layer known as lithosphere. The lithosphere is broken into several segments known as plates having irregular shapes and sizes. Below the lithosphere, there is asthenosphere which is the weak region of the mantle where the temperature and the pressure are such that the rocks there are at their melting temperature. This layer responds to stress by flowing and thus the uppermost rigid layer is able to move independently. The lithosphere constitutes about 20 plates generally known as lithospheric or tectonic plates which are in constant motion with respect to one another. The major plates covering the earth's surface area are the North American plate, the South American plate, the Pacific, the African, the Eurasian, the Australian, the Indian and the Antarctic plates (Figure1). All these plates are in constant motion showing constructive and destructive phenomenon.

Plate tectonics is the scientific theory that describes the large-scale movement of the lithospheric plates of the earth over the last hundred millions of years. Tectonic plates are able to move because of the larger mechanical strength of the lithosphere than that of the asthenosphere. The plate tectonic theory is the United theory of continental drift and seafloor spreading which describe the movements of the plates in course of time that has led to the present position of the continents and oceans.

Continental drift is the horizontal movement of the continent in the vast scale. Alfred Wegener, a German meteorologist and geophysicist in 1915 gave the hypothesis of continental drift on the basis of different

geological, tectonic, geophysical and meteorological evidence. The presence of same type floral and faunal fossils, the stratigraphic, lithological similarities and the boundaries of different continents provide the evidence favouring continental drift. He suggested once there existed a supercontinent of all earth's landmasses known as Pangea surrounded by the large ocean Panthalassa before the Silurian Period. The Pangea broke into Gondwanaland in the south and Laurasia in the north during the Mesozoic era. Later in course of time, further continental drift took place and which finally led to the formation of present oceans and continents. These all movements of the lithospheric plates are due to the large-scale convection current in the upper mantle which can be transmitted through the asthenosphere. Similarly, seafloor spreading is the hypothesis proposed by the professor Henry Hess that describes the formation of the new oceanic crust through volcanic activities in the mid-oceanic ridges. Seafloor spreading helps explain continental drift in the plate tectonics theory. The mid-oceanic ridges are situated over the rising limbs of convection current in the Earth's mantle. He suggested that the seafloor might be spreading at the rate of approximately 1 cm per year. Different palaeomagnetic studies, the occurrence of earthquakes along the crest of mid-oceanic ridges and the deep oceanic or oceanic islands materials those are not more than 100 million years in age from the studies indicate as the evidence of seafloor spreading. Both the phenomena i.e. continental drift and seafloor spreading are interconnected to each other and as a result, tectonic activities of lithospheric plates occur.

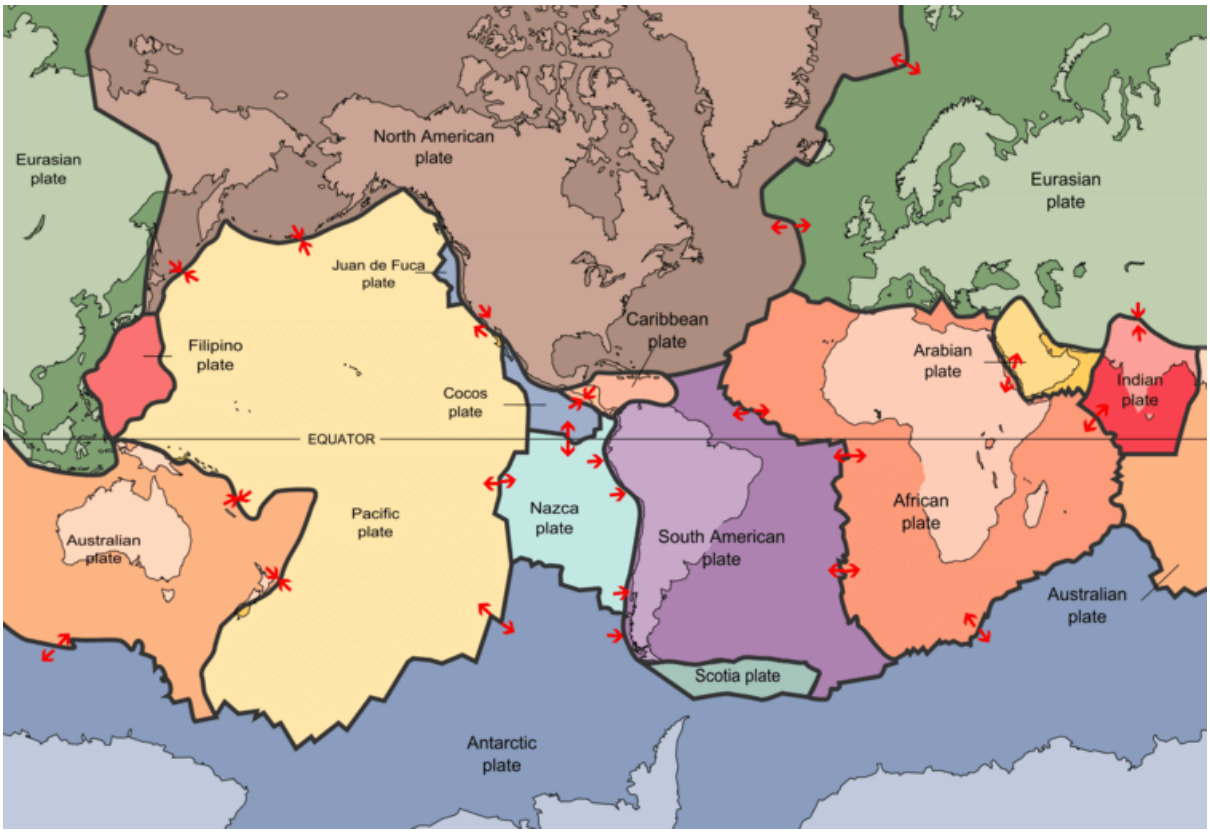

Figure 1 Major plate on the earth's crust

2. Discussions

Plate tectonics provides a modern view of the rock cycle. It involves a worldwide network of moving plates of the lithosphere. The plates are in continuous motion with respect to one another and with earth's axis of rotation. The activities of the earthquakes, volcanoes and other tectonic activities are mostly localized around plate margins and are associated with the differential motion of adjacent plates. Plate margin is the marginal part of any plate and plate boundary is the surface trace of the zone of motion between two plates. The plates are separated by faults and thrusts lying most across the ridges or parallel to the continental borders known as trenches. It is estimated that these plates move with the velocity of 1-6 cm per year. The plates are bounded by three distinct types of boundaries that are differentiated by the movement they exhibit.

1. *Divergent boundaries:* It is the constructive plate margin where two plates move apart from the crest of the oceanic ridge. Here the new crust is formed by the upwelling of the materials from the mantle. The plate boundary consists of a set of normal faults dipping about 600 from the horizontal.
2. *Convergent boundaries:* It is the destructive plate margin in which two lithospheric plates are coming together and one is forced to plunge down into the mantle. Here the plate boundary will be a reverse fault dipping at angles of 300 from the horizontal. In this case, the two continental blocks collide to create a mountain system.
3. *Transform fault boundaries:* It is the conservative margin where two plates grind past each other without the production or destruction of the lithosphere.

The plates may be either continental or oceanic or both but only those parts of plates which can be capped by oceanic crust can participate in the main process of plate growth and destruction. There are several causes of plate motion identified by the study. They are:

1. Formation of new crust at mid oceanic ridges which is the continuous process and estimated that it spread at about 1-6 cm/year that let the plate in motion.
2. The ridges are close to isostatic equilibrium but the sinks that are characterized by the topographic trenches which show the largest negative gravity anomalies which cause the plate motion.
3. At the ridges the flow of heat is high which decreases further at the area of the trenches and again in the adjacent island arcs the flow is high, thus these differences in the value of heat also help for plate motion.
4. Similarly, the convection current condition in the mantle zone is also responsible for the plate motion as the diverging current drags the lithospheric plates along the direction of their flow.

The theory of plate tectonics is important in explaining the different phenomenon of the dynamic earth system. The framework of plate tectonics has made geologist to understand the geological distribution of earthquakes, volcanoes and mountain belts. The phenomenon of orogeny i.e. mountain building (where two continental plates collide with each other), the formation of

island arcs by the subduction of an oceanic plate beneath the continental plate and formation of oceanic trenches and mid oceanic ridges are all due to the motions of the plates (Figure 2).

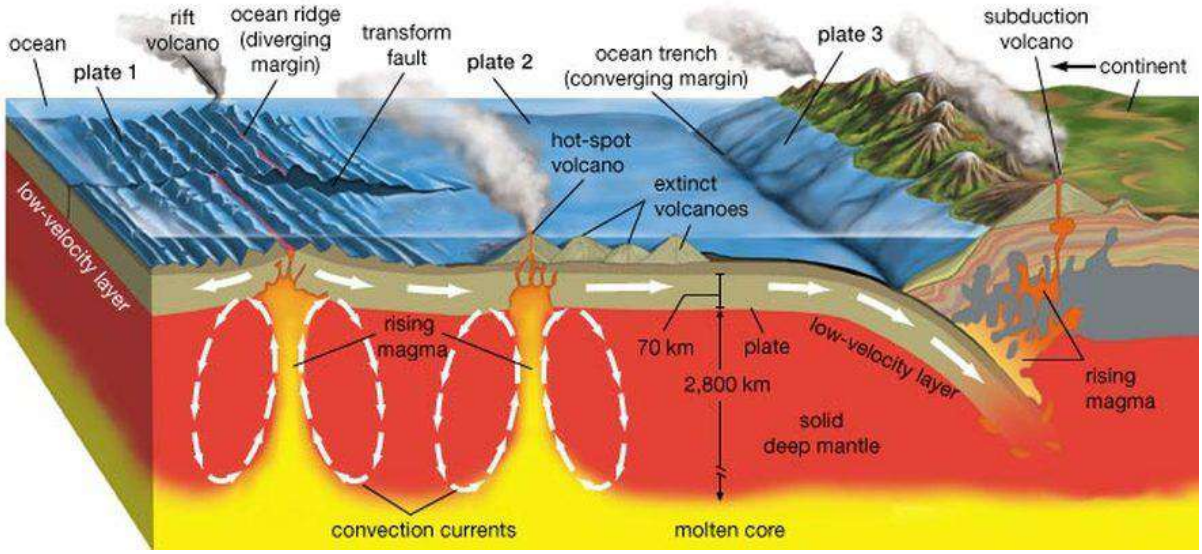

Figure 2 Plate Tectonics and their results

3. Conclusion

Geoscientists are always curious and in the state of knowing what might happen next in the physical, chemical and biological aspects of the earth. Plate tectonics is one of the theories resulted by their curiosity. Simply the theory of plate tectonics describes the fact that place, where we are living now, was once at a different portion of the earth and it will be again in the different portion after millions of years. New researches and methods have made to learn about plate movements in an efficient way. Thus the study of plate tectonics is always filled with findings something new facts that have been influencing on the environment, climatology, biological and overall physio-chemical system of the earth in various ways.

ACKNOWLEDGEMENT

I would like to express my deep gratitude to Department of Geology, Tri-Chandra Campus for providing this wonderful opportunity to write something that we have learned from our four years of geological study.

I am greatly obliged to my friend Mr Ankit Dhakal who have assisted and encouraged me in completing this article. Heartily thanks for all my teachers and colleagues for helping me directly and indirectly for writing this article.

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About the Author of *Plate Tectonics*

Name: Prafulla Tamrakar
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I am Prafulla Tamrakar, born on 28th April 1993 in Bhaktapur. I completed my SLC from Jaycees Secondary School and did my plus two from Khwopa Higher Secondary School. I like watching movies, playing football and exploring new places. I used to dream of becoming a pilot but that did not happen. After my plus two, I prepared for medical entrance examination for nearly one and half year but the luck did not favour in that case too. Then I heard about Geology subject that includes lots of branches of study related to the physical, chemical and biological aspects of the earth. Nearly twenty months after completing my intermediate study, I joined Tri-Chandra Campus to study geology with botany and zoology being my other subjects.

Within one week in the college, I got familiar with the environment over there and made some good friends who now have been the best part of my life. I focused on geology more than other subjects from the first year but I managed to do better in other subjects too. From the four years of study, I find out that geology is very determined subject and it is related to other fields of study directly or indirectly. What I like the most is that the earth where we live includes those types of elements which are always in the process of changing from the date of their birth, which a normal person cannot understand but a geologist can feel them even if the single life of a person is not enough to understand all those processes.

Besides studying geology, I like to study about history that seems always mysterious and about universe and astronomy that is something beyond our imagination. History is such subject that has influenced me from the school time where we used to study them in social studies. “Seto Bagh” is the novel that I have gone through recently written by Diamond Shamsher Rana about the family of Junga Bahadur Rana. I have also gone through various papers and articles related to the history of different countries and people. The study of the universe is somehow related to geology and I am looking forward to gaining more and more information about that.

Nevertheless, I have completed my four years of geology study with memorable field trips, making really good friends and gaining lots of knowledge that has influenced me to carry my further higher study and become a successful geologist in the future.

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GEOLOGICAL FEATURES OF NEPAL AND THEIR USES IN ADVENTURE SPORTS

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Abstract

This paper gives the summary of occurrences of different Geological features in Nepal. And their uses in different adventure sport. In Geological point of view, the geology of Nepal is very complex because of geodynamic movement .Due to the ongoing mountain building process there are many geological features which are developing and many geological features which are disappearing. Geological features are nowadays used as backbone of many adventure sports. Features like Hill, Mountain, Cliff, Gorge, River, Fountain, Lake, Glacier, Terrains, Cave, etc. are present in Nepal which is used in extreme sport.

Key Words: *geological features, adventure sport, extreme*

1. BACKGROUND

Nepal is a land locked country which lies in the central part of Himalayan range. About one third part of Nepal is covered by mountain and hills. Nepal covered the area of 1,47,181 sq.km. Though the area of Nepal is small, but Nepal is rich in biodiversity. There are many geological features in Nepal which are very important for extreme sport. People can enjoy many extreme sports in Nepal like mountain climbing, rock climbing, paragliding, bungee jumping, swing, rafting, zip flyer, canyoning, kayaking, glacier climbing, mountain biking, caving, trekking etc. Nepal is paradise for people who love adventure sport. Many people all around the world came in Nepal for doing this type of extreme sport.

2. OBJECTIVES

The main objectives of this article are:

- To inform about extreme sports which can be performed in Nepal
- To understand about different geological features
- To understand present status of extreme sport in Nepal

3. METHODOLOGY

Much of information in this article is collected via direct observation and some information is collected from journals and websites etc.

4. RESULTS AND DISCUSSION

Nepal is a paradise for the people who are seeking for adventure. Nepal offers many extreme sports which can be done in different geological features.

4.1. Mountain, hills, rock, glacier and their climbing

Nepal is mountainous country there are many mountain, hills, glacier and rock mass. These types of geological features are developed due to geodynamic movement. Geological process like folding, faulting, volcanic activity, igneous intrusion etc. are

responsible for formation of mountain which offer extreme sports like trekking, mountain climbing, rock climbing. Many parts of Nepal offer these types of extreme sports.

4.2. Paragliding and Zip flyer

Paragliding and zip flyer are extreme sport which are done from higher places like hills to the lower places. Paragliding can be done in many place of Nepal and zip flyer can be experienced in Pokhara which is vertical drop of 600m over a distance of 1800m, it is the world longest, steepest, tallest and fastest zip line.

4.3 Bungee jumping and canyon swing in gorge

Gorge means deep, narrow valleys with a stream or river running along their bottom. Gorges are formed by most common geological process like erosion due to stream or river. Bungee jumping means jumping from higher places like bridge over gorge by the help of rope .and canyon swing means swinging from high place using rope. There are many gorges in Nepal which are made by the current of fast flowing rivers. The last resort in Sindhupalchowk offers both bungee and swing over Bhote Koshi River. You can experience thrill and gravity defying adventure.

Figure 2 Bungee jumping

4.4. Rafting and kayaking in rivers

River means large mass of water, which is form from underground streams, formed after rain or snow seeps into the ground then bubbles back to the ground. There are many rivers in Nepal and Nepal is one of the best white water rafting sites. Tumbling from the snowcapped peaks of the great Himalayas, the rivers of Nepal provide some of the most exciting rafting and kayaking in the world. Rafting means to transport on raft down the river to a group of people and kayaking means travel in small canoe down the river, in kayak single person can travel. Rivers like Trisuli, Bhote Koshi, Kali Gandaki, and Seti are famous for white water rafting in Nepal.

Figure 3 Rafting

4.5. Canyoning in waterfalls

Waterfalls often form in the upper stage of river where it flows over different bands of rock. Waterfalls are formed due to eroding of soft rock than hard rock. The unique topography, high altitude and large quantities of fresh water from the mountain, most of the Nepal's rivers offer a great Canyoning adventure. Canyoning is extreme sport in which we go against the flow of water by the help of ropes. It is astonishing full body and mind experience filled with stunning scenery, karst rocks and waterfalls.

Figure 4 Canyoning

4.6. Mountain biking in hills and Terrain

Nepal is nowadays becoming enticing destinations for mountain biking. Tough climb, thrilling down hills, fast, flow single track while enjoying the spectacular trails will make one ecstatic. So Nepal is best place for mountain biking.

5. CONCLUSION

Nepal provides unlimited adventure options for all types of adventure lovers with activities like mountain climbing, rafting, bungee jumping, biking, paragliding, rock climbing, boating, canyoning, zip flyer, fishing, hunting, canoeing etc. Geological features are the infrastructure for many extreme sports. There are many extreme sports which can be done in Nepal. These extreme sports are the infrastructure for the development of the tourism sector. These types of sport attract many people from all around the world and help to grow tourism industry. This will play important role in economy of the Nepal. Because when tourism industries are developed, many jobs

evolve. This will be beneficial for Nepal to become economically strong because tourism is best option to earn foreign currency. These types of extreme sport are best ways to promote the country. So we should discover new place which can be useful for adventure sport.

Government should make proper plan and polices for searching potential geological features which can be used as sources of extreme sport, development of infrastructures in those places so that those geological features can be used for extreme sport so that we can take benefits from these source of tourism.

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I would like to thank to Tri-Chandra campus, department of geology for giving me opportunity to write this article. I would like to thank to our respected teacher Dr. Tara Nidhi Bhattarai for encouraging me to write this article. I would like to thank the member of editorial board. Similarly, I would like to thank teachers of geology and my friends for their encouragement. Lastly thank you Mr. Bill gates for such a wonderful program MS Word without which I wouldn't able to write this article.

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Curios Innovations PVT.LTD.

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I was born in Badavairav VDC, Ward No. 3, Dailekh. But I spent little time there. My childhood was spent in Kohalpur-10, Banke district and I completed my S.L.C from Deep Jyoti Vidyashram Secondary School, Kohalpur. I passed my +2 from Nepal Police Higher Secondary School, Sanga, Kavre. Currently, I live in Samakhusi, Kathmandu. In the year 2070 I was admitted in Bachelor's level for B.sc at Tri-Chandra campus.

I love reading and I have gone through many books. *The Alchemist* novel by Paulo Coehlo attracted me most. It shows the journey of a shepherd boy named Santiago, who went on a long journey believing a recurring dream to be prophetic.

There are many Unforgettable moments during this four year at Tri-Chandra campus. Geology was totally a new subject to me; I choose to study Geology because of my friend. And I must say that was my best decision. I really enjoyed studying Geology. Field works during 3rd–and 4th year were fascinating because those fieldworks helped to understand the geology practically.

I love to do adventurous thing, beside that I love travelling, playing and watching cricket and football and reading novel etc.

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IMPORTANCE AND USE OF ARCGIS IN GEOLOGY

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Abstract
ArcGIS is computer software developed by ESRI (Environmental Systems Research Institute) to make an easy way to better understanding the field information on our pc. Day by day its importance and uses are becoming broad on Geology. Centre work of GIS is mapping which can be done by ArcMap. It is connected with Google earth by which we can work only on study area by selection. It is also connected with AutoCAD, Remote sensing, Global positioning system.

1. INTRODUCTION TO ARCGIS

ArcGIS is a computer program developed by ESRI with the help of many members through over the world. It helps to determine different parameters by one click on our PC which is almost impossible without it in the very short period. It is the computer program with which 3D visualization of any area and field observed data is possible. ArcGIS helps to question, analyze, database management, and interpretation of the data to understand the relationship, pattern, and trends between the obtained field data on different parameters. ArcGIS provides contextual tools for mapping and spatial reasoning so you explore data and share location-based analysis. ArcGIS gives the better, quick and easy information on geography, hydrology, etc. and also connects them. These abilities of ArcGIS make it different and better than other GIS software. ArcGIS is advancing rapidly integrating and leveraging many innovations, comparing infrastructures.

GIS is also known by "the science of where". It means Geographic Information System which incorporates other sciences like geography, data science, the physics, mathematics and computer science. GIScience is the applied science and mapping is the frame work of the GIS. It is the technical platform for managing, analyzing, and applying Geographic information. GIS is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data. It sometimes used for geographic information systems and is a large domain within the boarder academic discipline of geoinformatics. GIS can refer to a number of different technologies, processes, and methods. It is associated with many operations and has many applications related to engineering, planning, and management. GIS uses the coordinate system information and projections to make and study maps. Web GIS is the modern GIS architecture helping everyone do their work better sharing knowledge collaboration. Web GIS simplifies working with all types of data.

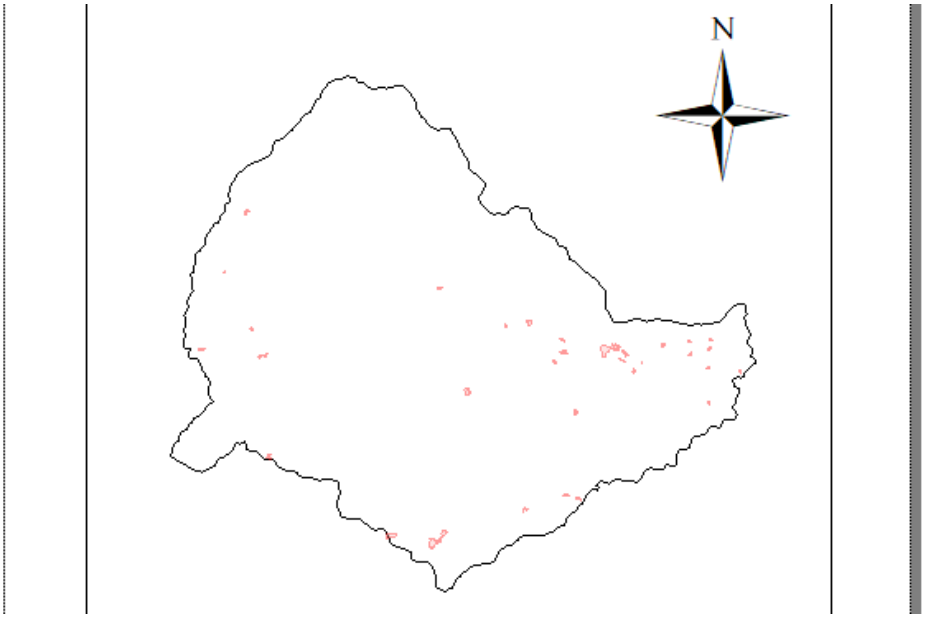
2. IMPORTANCE OF GIS IN GEOLOGY

GIS is more useful today with increasing knowledge of its importance. Men always want to be more advanced and smarter.

They want to know about the Earth by sitting in one corner of the world. GIS facilitates the people in doing this. GIS is also a system for interacting with people. Some importance of GIS in Geology and related to the Geology are listed below.

- For Mapping and Detection of coal mine fires.
- For Environmental and impact management, disaster management, mitigation and natural resources management.
- To provide the idea about land use changes associated with open cast strip mining.
- For a collection of information about geographic features for mapping and to provide world earthquake information system.
- Its importance is also on manage project on the basis of different parameters like public residential, the number of schools, the density of houses in a community, roadways, elevation difference and slope of the area.

The figure below shows the different landslide of Okhaldhunga district by using GIS and Google Earth:



Use of GIS in Geology:

- GIS is used to study Geographic features, analyze soils and strata, seismic information, and or create 3D displays of geographic scene features.
- GIS is used to analyze rock/soil characteristics and identifying the best dam-site location.
- Used to landslide hazard zonation and Flood damage estimation and for soil mapping, Geologic mapping and digital mapping.
- Slope stability representation and aspect representation, contouring from any area of field data.

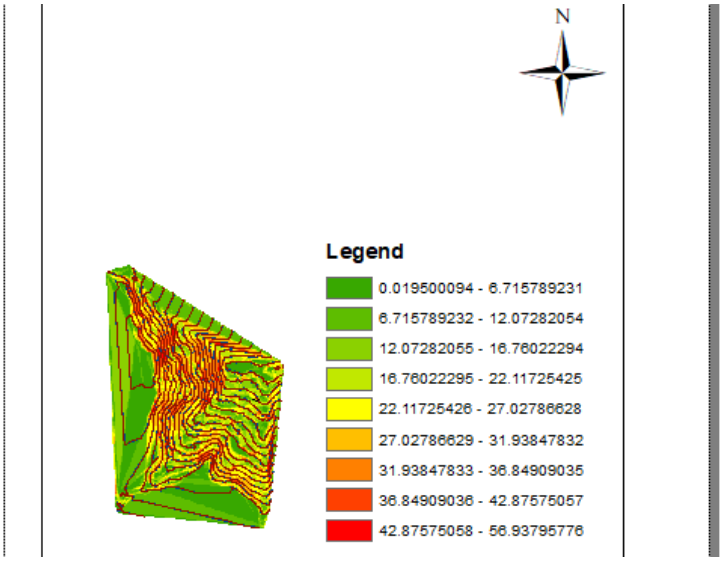


Fig. 2 Slope stability representation by using GIS

3. CONCLUSION

The use of GIS for different purposes is making it an important tool for geologists. The knowledge of ArcGIS is a must for geologists because it is the most widely used software for the GIS. The GUI (Graphic User Interface) of the software, the web resource, and the different perspectives it provides are helpful in preparing models for several geological problems and to provide the solutions to them.

ACKNOWLEDGEMENT

I am thankful to my Tri-Chandra college, department of geology for giving me the opportunity to write an article. I express sincere gratitude to Dr Tara Nidhi Bhattarai for all kind of encouragement to write this article. I would like to thank all the members of the editorial board for their valuable comments and advice. I would like to thank also those people who help me to write this article Mr Raju Pandey, Er Basanta Parajuli.

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About the Author of *Importance and Use of ArcGIS in Geology*

Name: Kiran Pandey

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Year of admission: 2070

I was born in Rampur-7 Buka, Dang as a first son and also first children of my parents: Homraj Pandey and Roopshila Pandey. I am starting to stay with my grandmother (mother of mother) instead of my mother on Chaughera-Dang. I spent my 5 years at Chaughera until I have been passed class 2 in government school named as Gorakshya Ratnanath Madhyamik Vidhyalaya. Then I started to live with my father for 8 years until I passed my SLC examination on B.S. 2067/68 with first division (62%).Then I stay in Ghorahi-campus road for my further study by where I have completed the +2 in science from Padmodaya public model higher secondary school with first division (62%) on B.S. 2070. Since that time I stay on Kathmandu for the study of Bachelor's Level in Tri-Chandra campus. In my college time, the most memorable moment was the educational tours of Malekhu and Palpa, where I gained a lot of practical knowledge from my teachers and friends, they helped me in my problems.

I choose the combination GSM because by the help of my brother Hukum Paudel. I am always interested to learn something about the rocks and the history of topographic features since I was studied on +2 science. I am interested in visiting new places, watching motivation and inspirational movies, hiking with friends, use of tricks on every subject of study and work. I visited Sworgadwari temple of Pyuthan thrice by foot, and so many places of Kathmandu also visited on my hiking.The best and unforgettable memory of the hiking of my life is hiking to the Sworgadwari.I watch the motivational as well as inspirational movies Pursuit of happiness, 3 Idiots, Anand.

I am interested in the use of computer programs for Geology. Many computer programs can be used in Geology for better understanding, interpret and analyze the field information. Some of widely used those types of computer applications are GIS, RS, GPS, DGPS, GoogleEarth, AutoCAD, etc.

Since last year I have been learning the computer programs which are helpful on the geology and mapping. I want to be a good geologist and my next hobbies are to do mapping of the many areas of Nepal, Hazard zonation. Every year in Nepal, we lose properties due to different disasters. So I prefer to work on risk management committee.

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RIVER POLLUTION

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Abstract
Water pollution is a major problem in the global environment. This necessitates continuing assessment and review of water resource policy at all levels. The main objectives of this article are to investigate major sources causes and challenges to control river pollution. The practical solutions minimizing the present river pollution would prevent the people from various diseases which are related to water pollution.
Keywords: Pollution, Rivers, Human Activities

1. INTRODUCTION

Water pollution today is considered a major issue not only in our country but all over the world. The quality of natural water in rivers, lakes, reservoirs and below the ground surface depends on a number of interrelated factors. As we know during its movement on and through the surface, water has the ability to react with the minerals that occur in the soil and rocks and to dissolve a wide range of materials, so its natural state is never pure.

A primary reason for this is that all three major sources of pollution (industry, agriculture and domestic) are concentrated along the rivers. Industries and cities have historically been located along rivers because the rivers provide transportation and have traditionally been a convenient place to discharge waste. As an important subsystem of the urban environment; urban river offers many kinds of ecological services which benefit the city dwellers. However, with the acceleration of urbanization and rapid development of the economy, urban river pollution problem is becoming more and more critical.

2. OBJECTIVES

- To control the major cause of water pollution caused by human themselves.
- To make the responsible agencies alert about this water pollution which helps to reduce the present level of water pollution.

3. METHODOLOGY

3.1. **Desk study**: The existing reports and published articles were reviewed as it was hard to investigate and collect data individually in a short period time.

3.2. **Field study**: Field observation of rivers such as Bagmati, Manohara, Bishnumati, Tukucha, Hanumante, etc. was done and interacted with the community people about the causes and effects of the pollution.

4. FIELD INVESTIGATION

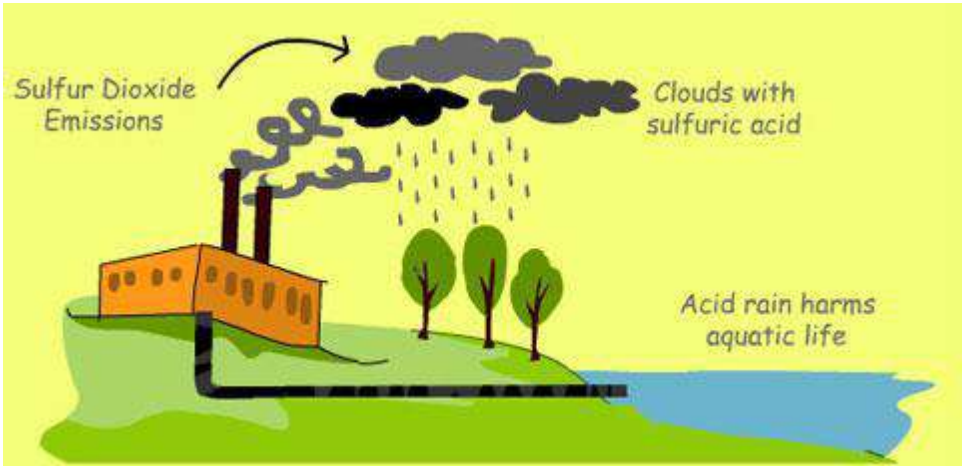
4.1. Causes of water pollution:

4.1.1 Sewage and waste products: Disposal of sewage waste is a major problem in our country. In many developed countries, the sewage is first treated, cleaned and dumped into the rivers. Even though treated they are never the same as fresh water. But in developing country like ours, the waste and sewage without cleaning are dumped quickly into the rivers that contaminate the water bodies and cause pollution of rivers.

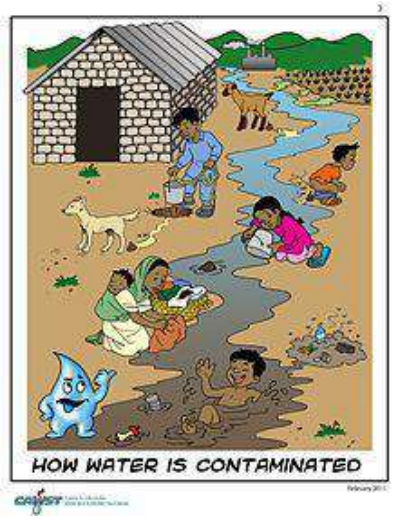
4.1.2 Industries cause huge water pollution with their activities as they contain sulphur, asbestos, lead, mercury, nitrates and phosphate which remain in the atmosphere and mix with rivers that may cause acid rain which pollutes the sources of water. In addition, biofuel using old vehicles produces

a lot of toxic gases which also support for acid rain.

4.1.3 Fertilizers used in agriculture contain nutrients such as nitrates and phosphates. High human caused concentrations of nitrogen and phosphorus in water often results in a rapid increase in algae. The algae block sunlight to plants below and those plants eventually die. Also, the algae consume oxygen as they decompose there by lowering the oxygen content of water and aquatic animals may die as well.



4.1.4 People are still unaware of the effects of water pollution due to which they conduct different household activities like cleaning dishes, washing clothes, bathing etc. directly in the water source. This is very unhealthy and causes pollution of water bodies.



4.2. Control measures on pollution

4.2.1 Sewage treatment: Domestic sewage can be treated by centralized sewage treatment plants. Well-designed and well-operated systems can remove 90 percent or more of the pollutant load in sewage. So, the sewage must be first treated, cleaned and dumped into the rivers. Even though this does not remove pollution but somehow the adverse effects can be controlled. Some plants that have additional systems to remove nutrients and pathogens must be planted.

4.2.2 Industrial wastewater treatment: Some industrial facilities generate ordinary domestic sewage that can be treated by municipal facilities. Industries that generate wastewater with high concentrations of conventional pollutants, toxic pollutants or other non-conventional pollutants such as ammonia need specialized treatment systems. Some of these facilities can install a pre-treatment system to remove the toxic components, and then send the partially treated wastewater to the municipal system.

4.2.3 Agriculture wastewater treatment: Farmers can develop and implement nutrient management plans to reduce excess application of nutrients and reduce the potential for nutrient pollution. They may use Integrated Pest Management (IPM) techniques which can include biological pest control to maintain control over pests, reduce reliance on chemical pesticides, and protect water quality.

4.2.4 Erosion and sediment control from construction sites: Sediment from construction sites is managed by the installation of erosion controls, such as mulching and hydroseeding and sediment controls, such as sediment basins and silt fences.

4.2.5 Dredging: Dredging helps in reduction of soil contamination that was caused by sewage sludge, wilted plants, or chemical spill.

4.2.6 Bokashi: Bokashi is a modern method of water pollution prevention to decrease smell. It is Japanese process for an antimicrobial solution used to kill germs either bacteria or fungi that cause foul odour and digestive tract diseases, and algae.

5. CONCLUSION

Water pollution is directly related to the lives of people as water is an essential aspect of living beings. The pollution of rivers is mostly caused due to human unhygienic behaviour. The use of water cannot be controlled but pollution of water can obviously be controlled. Every citizen should be aware of the consequences of pollution and be responsible for the waste management so that we can promote sustainable development without disrupting the ecosystem and hence enhance the quality of life.

ACKNOWLEDGEMENT

I would like to express my foremost gratitude to Dr Tara Nidhi Bhattarai for providing me with the opportunity to write this article which has increased my knowledge and understanding. I would also like to thank the Department Of Geology for providing me with the golden opportunity to contribute in publishing Geoworld magazine which has enriched my knowledge on the subject matter.

I would like to thank all those concerned who were involved directly or indirectly to build the manuscript, although any errors are my own and should not tarnish the reputations of these esteemed persons.

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About the Author of *River Pollution*

Year of admission: 2070
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Born in Thapathali, Kathmandu, I completed my school level studies as well as 10+2 from V.S. Niketan Higher Secondary School, Tinkune. I actually wanted to get recognition in the microbiological field. I had no idea what Geology was until one of my college friends familiarized me with this branch of science and its scope. After I heard about geology I actually found the subject to be interesting so, I joined Bachelors in Geology.

I don't read much but the best novel I have gone through is "Seto Dharti" by Amar Neupane where a girl has to live her life as a child widow. The story mainly tries to reveal the terrible cultural practice, in the name of religion, called child marriage.

Tri Chandra Campus was not the part of my plan after the completion of my high school education. That's why I was not fond of attending college in the beginning of my college days. But when I got transferred to Geology subject, the subject really impressed me and I started to attend all the classes regularly. After these four years of studying I find engineering geology the most interesting subject among all.

The campus gave a lot of good memories that I can remember in my old days and laugh at myself. The field trips helped me gain a lot of knowledge about geology but most importantly it taught me to make friends and that's the greatest achievement for me.
I believe I will be a skilled geologist in near future and be a part of developing the country.

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UNDERSTANDING THE PLANETARY GEOLOGY AS THE PART OF GEOLOGY

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Abstract
Planetary geology, alternatively known as astrogeology or exogeology, is a planetary science discipline concerned with the geology of the celestial bodies such as the planets and their moons, asteroids, comets, and meteorites (J. F. Bell III, B. A. Campbell, M. S. Robinson, 2015). This includes such topics as determining the internal structure of the terrestrial planets, and also looks at planetary volcanism and surface processes such as impact craters, fluvial and aeolian processes. In the early 1960s, Eugene Shoemaker contributed towards the bringing of geologic principles to planetary mapping and creating the branch of planetary science.

Keywords: *Planetary geology, Exogeology, Volcanism, Impact Crater, Celestial bodies.*

1. BACKGROUND

Understanding the earth and earth elements is not an easy stuff. There are many fundamental things to know about the geology. Earth's evolutionary history is the major part of geology. Geology is not only based within the earth's surface but it also deals with the planets and their celestial bodies. This is called as *Planetary Geology.*

Planetary geology includes the terrestrial planets, their internal structure and also it serves to planetary volcanism and their surface processes such as fluvial and aeolian processes. It describes about the origin of planets and their satellites. It also describes the physical characters of the earth and their properties.

1.1 Origin of planetary geology

Today, the planetary geology has been broadly studied and understood. There is the importance of studying about the planets and their characteristics. This is possible all because of Eugene Shoemaker, the father of Astrogeology, from Space and Technology.

According to Shoemaker (1961) "Planetary geology is the study of physical characteristics of planetary bodies in the solar system". Specially, planetary geologist studied about the planets, their satellites, the development and the formation of them. At first, it may seem that this study only serves the purpose of gaining information for the sake of increasing a sum of knowledge; however, understanding these worlds has the very practical application of better understanding Earth's own geology. While Earth's geology is obviously the best understood of the planets in the solar system, very little can be said definitively about how Earth existed in the past or how the surface will develop in time. By better understanding attributes of other planetary bodies such as the volcanoes found on Mars, Venus, and satellites of Jupiter or the atmosphere of Titan (Saturn's giant satellite), geologists are able to better

understand how these attributes of Earth's geology behave when crucial factors (i.e. temperature, chemical composition) are varied.

1.2 Importance of planetary geology

Among the different branches of geology, planetary geology is the one. It deals with the characteristics and physical properties of the planets and celestial bodies. This is as important as the other branches of geology such as geophysics, geochemistry, seismology, paleontology, sedimentology, petrology and many more.

We live in the planet, Earth. We have our solar system. We studied lot about the solar system and the entire planets along with their satellites, meteorites, asteroids, and so on. This geology deals with these all. During the research by the planetary geologist on the sample collected from Mars and Jupiter, they have found that there is also the occurrence of geologic processes such as aeolian process and also they found the frequent volcanic eruption. In the laboratory, we analyze extraterrestrial materials, such as meteorites and moon rocks, which helps in the observation of our solar system (and other solar systems), or develop models of the evolution of planets and planetary systems. Planetary geology has great importance because it describes about the origin and the development of our solar system. It also describes how geological processes that are familiar from the Earth have worked to shape different planetary environments.

2. OBJECTIVES

The main objective of writing this article is because of following points:

- It helps all the learners to know about planetary geology as the part of geology.
- It tells us about the origin and formation of our solar system and other terrestrial bodies.
- This describes about the different geologic processes occurs on the planets.
- It provides us the idea about the importance and need of planetary geology.

3. METHODOLOGY

I first of all access my internet and search in the related topics. I used Google and Wikipedia to download all the available articles and journals in the related topics. No any primary data were collected. All the information gathered are as secondary data.

4. RESULTS AND DISCUSSION

4.1 Factors affecting the appearance of impact craters and ejecta

The circular features so obvious on the Moon's surface are impact craters formed when impactors smashed into the surface. The explosion and excavation of materials at the impacted site created piles of rock (called ejecta) around the circular hole as well as bright streaks of target material (called rays) thrown for great distances.

Two basic methods forming craters in nature are: 1) impact of a projectile on the surface and 2) collapse of the top of a volcano creating a crater termed caldera. By studying all types of craters on Earth and by creating impact craters in experimental laboratories geologists concluded that the Moon's craters are impact in origin.

The factors affecting the appearance of impact craters and ejecta are the size and

velocity of the impactor, and the geology of the target surface.

By recording the number, size, and extent of erosion of craters, lunar geologists can determine the ages of different surface units on the Moon and can piece together the geologic history. This technique works because older surfaces are exposed to impacting meteorites for a longer period of time than are younger surfaces.

Impact craters are not unique to the Moon. They are found on all the terrestrial planets and on many moons of the outer planets.

On Earth, impact craters are not as easily recognized because of weathering and erosion. Famous impact craters on Earth are Meteor Crater in Arizona, U.S.A.; Manicouagan in Quebec, Canada; Sudbury in Ontario, Canada; Ries Crater in Germany, and Chicxulub on the Yucatan coast in Mexico. Chicxulub is considered by most scientists as the source crater of the catastrophe that led to the extinction of the dinosaurs at the end of the Cretaceous period. An interesting fact about the Chicxulub crater is that you cannot see it. Its circular structure is nearly a kilometer below the surface and was originally identified from magnetic and gravity data.

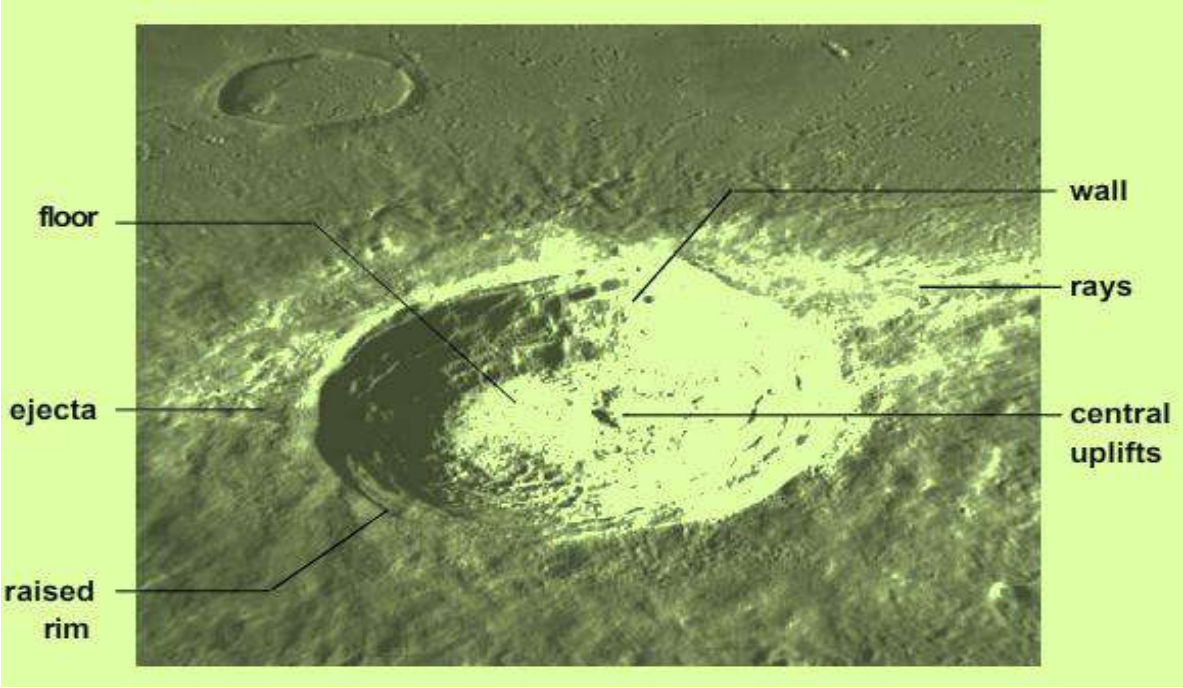

Fig. 1 Photograph of lunar impact crater Aristarchus, 42 km in diameter, located West of Mare Imbrium (Photo Source: NASA).

1) Raised rim - rock thrown out of the crater and deposited as a ring-shaped pile of debris at the crater's edge during the explosion and excavation of an impact event.
2) Floor - bowl shaped or flat, characteristically below surrounding ground level unless filled in with lava.
3) Central - mountains formed because of the huge increase and rapid decrease in pressure during the uplifts impact event. They occur only in the center of craters that are larger than 40 km diameter.

4) Walls - characteristically steep and may have giant stairs called terraces.
5) Ejecta - blanket of material surrounding the crater that was excavated during the impact event. Ejecta become thinner away from the crater.
6) Rays - bright streaks starting from a crater and extending away for great distances.

5. CONCLUSION

Planetary geology is a branch of geology and it gives the information of planets, satellites and all those activities that occurs on the planets and the surfaces of earth as well as on the surfaces of moon such as volcanic process, aeolian process and impact craters. Impact craters are formed by the falling of meteorites, asteroids, comets, on the surface of planets and moon. Impact craters are not easily visible on the earth's surface due to the weathering and erosion but it is easily visible on the surface of moon because there is no water, no air, which causes weathering and erosion like activities.

Furthermore, this is a very interesting topic to study as it is related to the terrestrial bodies. It studied about the comets, meteorites, terrestrial bodies and about the entire solar system.

ACKNOWLEDGEMENT

I feel lucky enough to get this opportunity of writing an article. As the trend for the entire batch of B.Sc. 4^{th} – year to write an article in the relevant topics chosen by ourselves is the quite interesting one. It is an honor to grab this opportunity provided by the Department of Geology. Last but not the least; I am heartily thankful to the Prof. Dr. Tara Nidhi Bhattarai who provides us the special opportunity to write an article for the Geology World Magazine.

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About the Author of *Understanding the Planetary Geology as the part of Geology*

Year of Admission: 2070
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I was born in Dhangadhi-3, Kailali. I did my schooling from Kailali Model School, Dhangadhi and completed intermediate (+2) from Kailali Model Higher Secondary School, Utter-Behadi-4, Dhangadhi, Kailali. After my high school graduation I came to Kathmandu with the dream of becoming a Mechanical Engineer. I joined for the entrance preparation class to get admission in IOE, Pulchok but with no luck I am unable to get admission. Then with no any other option except joining B.Sc. I arrived at the premise of Tri-Chandra Multiple Campus with no positive hope of bright future because I had seen some of my seniors being graduated and having no jobs.

I had heard little about the Geology, a better subject to be enrolled in B.Sc. which has potential scope in Nepal. Right then, I consult with my seniors who were enrolled at Tri-Chandra and they suggested me to enroll in the Geology with the subject combinations of Geology, Statistics and Mathematics. I got admission and started my journey with the Department of Geology.

I am fond of listening to motivational speech. I have heard many speeches commence by different national and international motivational speaker. I somewhere heard that "If we really toil hard, everything will conspire together to fulfill our dreams". I define myself as a dreamer who dreams to be a successful person. A great philosopher once said that "A good dreamer is that who dreams more than his limit of dreaming". I really find the dreams as the way of living life.

On the very first day of my footsteps at Geology lecture hall, I met a charming person with the blushing in his face and he is non-other than our Prof. Dr. Tara Nidhi Bhattarai. His rules were very strict and should be strictly followed by each student during lecture hour. He has an inspirational voice. He taught us to become an optimistic person. He inspired us always. I learnt many things from him. I left my dream of becoming Mechanical Engineer back because of his worthily dedication towards students bright future. Thank You Tara sir. I feel grateful to become a part of the Department of Geology.

In geology, we studied many things about the earth, its origin and composition. We talked about the dynamic nature of earth. We go beyond the future and travel million years back.

We observe natural phenomenon and interpret it in real practices. Geology hence is unique in itself. We studied different branches of geology and also known that all has its equal importance in the Geology. We observed real geology and the rock formations during our field visit to Malekhu, Central Nepal. Furthermore, in our 4th year we visited to Palpa-Butwal area and there we got to know the vast change in the geology. These all practices increase my keen interest of becoming a geologist. Mining Geology is the keenly interested subject that I have found during my 4- year enrollment.

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GEOLOGICAL HAZARDS AND RISK MANAGEMENT

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Abstract:

Geological hazards are common in all parts of Nepal. Because of the location of Nepal in the geo-dynamically very active Himalayan belts it frequently suffers from the hazards and there is a considerable loss of about 865 lives every year (on average), huge loss of properties and damage of infrastructures. Hazard when interact with vulnerability it brings the disasters in the affected areas. Hazard maps are very important for disaster management, land use planning, infrastructure development planning, environment protection etc. Nowadays it becomes necessary to elaborate an specific model for the management of the geologic risks, that is adapted to the peculiarities of the current development of the building and infrastructure systems; and allow the use of the current tools as the GIS, Wombs, Analysis Cost Benefit, etc., for the organization and the control of the knowledge management and final quality of the executed works.

Key words: Risk Management, geology, hazard,

1. INTRODUCTION

A geologic hazard is an extreme natural event in the crust of the earth that poses a threat to life and property, for example, earthquakes, volcanic eruptions, flood, tsunamis (tidal waves) and landslides. Risk is a situation involving exposure to danger. Geological processes and the geological construct in the last 15 million years shaped the current pathway to human evolution in the same way natural environment and geology has been going hand in hand and influencing different kind of phenomenon in the surface as in the case of Nepal. The geology of Nepal is dominated by the Himalaya, the highest, youngest and a very highly active mountain range. Himalaya is tectonically divided into 5 divisions. Each is separated by different tectonic boundaries. Some of these boundaries are active thrust which leads to different geological hazards in Nepal. Earthquake is the major geological hazard due to the active tectonic boundaries.

Nepal is vulnerable to landslide hazard since time immemorial. The geomorphology, seismic sensitivity, intensity of monsoon rainfall and haphazard construction activities has made it susceptible to landslide hazard.

Nepal is characterized by rugged topography , high relief, variable climatic conditions and complex geological structures. Its topography ranges from 60 m to 8868 m within non-uniform mean width of 193km in Himalayan range which is formed by the collision of Indian and Eurasian plates. The major thrusts are active and Himalayas are still rising at the rate of 0.06 mm per year and the active tectonic process and seismic activities (Upreti & Dhital, 1996). Landslides have significant impact on social, economic, cultural and environmental systems in Nepal. Huge loss of lives and property during the hazards has been a regular phenomenon. The unplanned settlement, increasing population, weak economic condition and low literacy rate have affected the level of disaster

preparedness. A flood is an overflow of water that submerges land that is usually dry or 'an overflow of a large amount of water beyond its normal limits, especially over what is normally dry land.' Flood is major geological hazard of Nepal. There are plenty of plans and strategies to deal with disasters like earthquake and landslides.

2. CAUSES OF GEOLOGICAL HAZARDS

As landslide, flood and earthquake are the major geological hazards of Nepal. We are going to discuss about these three major hazards.

a. Landslide

Slopes are under stress because of gravity. When the forces acting on a slope due to the horizontal component of gravity exceed the strength of the materials that form the slope, the slope fails and movement occurs. Either internal changes (e.g. chemical weathering) and/or external changes (e.g. slope loading or shocks/vibrations) can affect the forces. However, it is important to note that the geographical distribution have been considerably modified in recent centuries by human intervention being precursor for landslide. Therefore, the triggers, causes both natural and manmade should be considered to analyze the cause of the landslide. According to Shrestha B.D, 2000: the triggers and causes of landslide are:

i. Landslide triggers

- Cloud burst (200-1000mm/day)
- Uncontrolled flow of water on slope surface from over flooded steep gullies.
- Earthquake
- Blasting of rocks
- Flash flood due to glacial lake outburst

ii. Causes

- Deforestation
- Blasting quarrying
- Hill cutting
- Irrigation of paddy fields, water storage ponds
- Undermining and tunneling
- Vehicle vibration in hill roads

Also different erosion processes like blocking of natural drainage, high flow velocities in steep gullies, pore-water pressure and geological conditions like mineral compositions, rock type and structure, etc. are some causes of landslide.

b. Flood

Flooding occurs most commonly from heavy rainfall when natural watercourses do not have the capacity to convey excess water. However, floods are not always caused by heavy rainfall. They can result from other phenomena, particularly in coastal areas where inundation can be caused by a storm surge associated with a tropical cyclone, a tsunami or a high tide coinciding with higher than normal river levels. Dam failure, triggered for example by an earthquake, will result in flooding of the downstream area, even in dry weather conditions.

Other factors which may contribute to flooding include:

- volume, spatial distribution, intensity and duration of rainfall over a catchment;
- the capacity of the watercourse or stream network to convey runoff;
- catchment and weather conditions prior to a rainfall event;
- ground cover;
- topography; and
- Tidal influences.

c. Earthquake

Earthquakes are usually caused when rock underground suddenly breaks along a fault. This sudden release of energy causes the seismic waves that make the ground shake. When two blocks of rock or two plates are rubbing against each other, they stick a little. They don't just slide smoothly; the rocks catch on each other. The rocks are still pushing against each other, but not moving. After a while, the rocks break because of all

the pressure that's built up. When the rocks break, the earthquake occurs.

3. DAMAGES BY MAJOR HAZARDS OCCURRED IN THE PAST IN NEPAL

Studies indicate that the loss due to landslides and related problems in the Himalayan region alone constitutes about 30% of the world's total landslide-related damage value (Li, 1990). Most of the landslides occur during monsoon period. Dahal et al., 2008, studied the relationships between rainfall and landslides taking 677 landslides occurring from 1951 to 2006 in Nepal to analyze rainfall thresholds. The study revealed that when the daily precipitation exceeds 144mm, the risk of landslides on Himalayan mountain slopes is higher. Similar observations were made by Kafle, 2003 at Matatirtha, west of Kathmandu.

Apart from such disastrous landslides, many small landslides go unreported as they occur in remote areas. According to the Department of Hydrology and Meteorology of Nepal, the major landslide events that have occurred in the past and have been recorded are listed below.

Year	Place	Loss
1967	Budhi Gandaki, Gorkha	9 died
1968	Budhi Gandaki, Gorkha	One bridge and 24 houses
1970	Tinau, Rupandehi	90 people los
1971	Palakhu, Rasuwa	5 died
1976	Baglung	7 died 3 bridges swept away
1982	Balefi, Sindhupalchowk	97 dead many houses destroyed
1986	Tadi, Nuwakot	31 died 24 houses 3 bridges destroyed
1987	Sunkoshi, Sipa	98 people 229 houses hydropower and Highway destroyed
1988	Myagdi Khola, Myagdi	109 died, 94 houses destroyed
1989	Bajhang	16 died, many houses destroyed
1996	Larche, Sindhupalchowk	54 people lost houses destroyed
2010	Madikhla, Kaski	Fertile land and houses swept away

On August 2, 2014, due to heavy rainfall, a landslide occurred at the Sunkoshi River. It killed 156 people. The debris blocked the river and formed a lake in Sindhupalchok District, Nepal.

Also flooding occurred in Nepal that caused many casualties. 1993 South Asian monsoon rain is one of the deadliest flood occurred in 1993 at different locations of Nepal, India, Bangladesh and Pakistan that caused 3084 casualties. Also 2002 Nepal flood, mainly occurred at Makwanpur, monsoon rain, flood, landslides caused 429 casualties in Nepal. In 2012 may flood at Pokhara caused at least 26 people have been killed and 44 are missing, including three Ukrainian tourists.

Earthquake is also one of the major hazard that marked many casualties in Nepal. Recently Gorkha Earthquake in April 25, 2015 with 7.8 Richter scale magnitudes caused 8922 fatalities and the biggest aftershock in May 12, 2015 with 7.3 Richter scale caused 213 fatalities. Many earthquakes have occurred in Nepal in the history and caused many casualties. 1934 Nepal-Bihar earthquake of 8.4 magnitudes with 8519 fatalities, Nepal-Tibet earthquake of 7.7 magnitudes with 3500 fatalities in 1961 and Kathmandu-Bihar earthquake of 8.0 magnitudes with 6500 fatalities in 1833, are some major earthquake that caused human and other losses in Nepal.

4. RISK MANAGEMENT

Risk is a situation involving exposure to danger. Risks are probability of event and it's suitably defined by four parameters: probability, time frame, severity and location. Identification, analysis, minimizations of those dangers to acceptable levels is the management of risk. Risk management in the Disasters manmade or natural, it is surely capable to do the structural damage and much more. To understand more about hazard or disaster to reduce it through a process, evaluation, analysis and minimizing the casual factors of disaster is the concept of risk management and geological hazards. Reducing the frequency of contact with hazard to people and property, including the wise management and early warning system falls under the risk management.

Risk Management is an instrument to prevent, prepare and taking counter measures to disaster or hazard such as those involved in the case are geological in nature. Risk associated with range of geo-hazards has risen dramatically in Nepal, also being very fragile geologically. Innovations in the technology has made it very proactive these days to get ahead assess the physical environments and possibly communicate with better understanding of the complexities. Technology such as GIS (Geographic Information System), Satellite imagery, digital maps can play crucial role in the management and controlling of hazard to be a risk and further being a disaster. It offers the past trend, real time and visual based analysis with the current impact on the landscape which geologist can study further and can point out the future out comings or a place a disaster most likely to occur from the field or from this technology.

Risk Management in geological hazards is not a new term, the success of the risk management are determined by how quick we are to get to the risk element of source and how we are able to take steps against it by acting proactively. Risk elements are best analyzed and evaluated with a integrated approach and feeding them to the system and studying the projection with severity of likeliness of its occurrence. In the case of landslide, floods, storms there are physical triggering points to the weather patterns that could be studied by modeling their behavior and interaction to be evaluated further involving hazard mapping.

Geological risks of natural kinds are those that are not produced at source by the hand of man, although could empower. According to origins, geological risks may be endogenous or exogenous (Galban, 2010). Those risks which can originate from inside the Earth because its structure and together are known as endogenous or come from outside and are called exogenous. Endogenous Geologic risks are Earthquakes, volcanic eruptions, liquefaction, tectonic movements, Tsunamis, natural gas and hazardous substances, cracks, cavities and landslides collapses, expansive soils, land subsidence and Exogenous geological risks are Storms, hail, cyclones, tornadoes, coastal flooding, river flooding, overflows of rivers and streams, erosion and sedimentation, salinization, wind erosion, landslides, rockslides, avalanches.

With the inclusion of risk management in geological hazards and Information Communication and Technology (ICT) and Geographic Information System (GIS), we can sustainably motivate disaster risk reduction strategies, just to name one: Hazus from FEMA (Federal Emergency Management Agency) can be a great incorporation to the development of new system here in Nepal. Geological risk assessment, risk perception and risk management is not in the present trend but if we could incorporate them to the present system here in Nepal, we can address the gap more proactively in a prepared way.

5. CONCLUSION

Increasing disaster risk in the region, Nepal's awareness and understanding of the risk management's applicability in geological hazard remains low. Risk Management can come up as a tool to dissect the source of risk and understand its impact to environment and geo-physical structure. It is yet to see how this can be incorporated to the strategies to identify and minimize the impact of the hazard. Risk management is an approach that leads to better decision making or understanding of those hazards also taking into consideration environmental issues as part of the risk mitigation and reduction strategies. A general strategy for disaster risk reduction must firstly establish the risk management context and criteria, and characterize the potential threats to a community and its environment (hazard); secondly it should analyse the social and physical vulnerability and determine the potential risks from several hazardous scenarios in order to, finally, implement measures to reduce them. There is a need of good coordination and combined efforts of the government, NGOs, INGOs as well as bilateral and multilateral agencies to deal with all types of disaster and save the vulnerable people, infrastructures and protect the natural environment.

ACKNOWLEDGEMENT

I acknowledge with gratitude my special thanks to the entire team of Department of Geology for giving us a chance to have a research in the interested topic inside geology. Most specially, I would like to thank my respected teacher Tara Nidhi Bhattarai who gave us this chance. Also, I want to thank my friend Biren GC who helped me write this article. I would also like to thank our chief editor Mr Ankit Dhakal who helped editing and suggesting new ideas about writing.

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About the Author of *Geological Hazards and Risk Management*

Year of Admission: 2070
Name: Anil Regmi
Roll No. : 962/070
Subject combination: Geology Physics Math (GPM)

I was born in Putalibazar Municipality- 1 of Syangja district as second son among the three brothers. I completed my school and high school from Roshani English Boarding Higher Secondary School, Syangja. After completion of +2, the journey of my Kathmandu life begun, firstly for the preparation of engineering entrance examination but didn't secure good marks to read engineering in government college. As I was not passionate to engineering, I easily gave up those small feelings of engineering. I use to live with my big brother in Kathmandu who studied in Tri-Chandra campus. He suggested me about geology. He told me some admiring words about geology that 'geology is one of the best departments, practical and field works are done in time, etc.; also the scopes and I fell in love with that word 'Geology' and i agreed to read. I joined GPM combination without much challenging. It's really very facile task to be here.

Straightforwardly, I have no future plans or something to do for future. I think present is where we live and future will be 'present' someday. So, I try to live today. I use to read books, watch movies and series and I'm sporty too. 'Karnali blues', 'Palpasa cafe', 'Che Guevara', 'Abstract Chintan:Pyaj', 'Gauthaliko Gud', 'Bimba Pratibimba', 'Jaya Bhudi', 'Galbandhi', 'Aaja ko Marxbaad ra Nepali Kranti', 'Sambridda Nepal', 'Naya Ghar', 'Mother', 'Ghumne Mech Maathi Andho Maanchhe' are some books i read. Shankhar Lamichhane and Bhupi Sherchan are my favourite writer and poet. I'am also interested in politics and support communism. Shawshank Redemption, Life of Pi, The Basketball Diaries, Zindagi na Milegi Doobara, Balidan, Inception, Special Forces are some of my favourite movies. Friends, Breaking bad, Game of thrones, Vikings are favourite TV series. Thoroughly, I just love watching series. And I have many friends.

Passion means very strong feeling and I am passionate to sporty activities especially playing badminton and travelling; though Swimming is my favourite. I always remember a sentence by Lee Chong Wei (Malaysian Badminton Player) "If we dare to win, we should also dare to lose". I do each and every task in my life not to win but to learn something more. I started playing badminton since my early childhood, so I think there is a sturdy attachment between Badminton and me. I was the district champion in U-19 badminton tournament, 2067 in Syangja also district school champion in 2066. I become second in all round district level badminton tournament 2070 organized in the occasion of Nepal Police day. Gosainkunda,

Ilam, Swargadwari, are some places visited and did some ventures like Bungee Jump and rafting.

In Geology, I am interested in tectonics and geological hazards. As Nepal recently suffered from some geological Hazards like earthquake and many landslides, with all the due consideration here, I have presented my article related to geological hazards and their risk management.

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EFFECT OF HUMAN ACTIVITIES ON SEDIMENTOLOGY AND GEOMORPHOLOGY

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Abstract: There is an intricate relationship of humans with nature but human activities have affected natural processes and conditions. The patterns of land-use have changed the rates of sedimentation and in turn affected the landforms and landscapes. The availability of machinery and technologies has helped humans modify the features of the earth much easily than they had done in the past. With improving technology and mechanical equipment, the certainty of humans ruling over all the parts of the Earth in the future has increased.

Key Words: *Geomorphology, Human Activities, Industrialization, Modern Equipment*

1. BACKGROUND

Humans have been modifying land ever since the advent of agriculture. They have ploughed and tilled the soil. They have also been excavating minerals such as copper, iron, coal and gold for different purposes. The industrial revolution, which began in the eighteenth century, has transformed the methods of agriculture and excavation. Humans also have now developed technologies not only for modification and destruction but also for the creation of landforms.

Human activities have changed the pattern of soil erosion and have increased landslides. The extraction of sand and gravel for construction activities has increased the rate of soil erosion on the younger parts of the river. Artificial structures such as dams and reservoirs have however reduced the amount of sediments that reach the sea. The mining of materials such as limestone, magnesite, and different minerals have changed the geomorphology of the mining site. Availability of modern equipment has made agriculture and extraction of minerals and construction materials much easier. Using modern technology, humans have also learned to construct new landforms.

2. OBJECTIVES

The objectives of the study are:

- To know about the human activities that affect the sedimentology and geomorphology,
- To understand the magnitude of change in sedimentation and geomorphic changes brought about by human activities,
- To assume the future consequences of landforms due to human activities.

3. HUMAN ACTIVITIES AFFECTING SEDIMENTOLOGY AND GEOMORPHOLOGY

Humans began significantly altering the natural state of soil ever since they adapted to agricultural practices. They tilled and ploughed the lands in order to ensure proper physical and chemical conditions of the soil for better crop production. They chopped down the trees and burnt down forests to

increase the area of their farmlands. Humans also modified the slopes and made terraces to suit for farming. Deforestation increased soil erosion in the alluvial plains and landslides became more frequent in the slopes that lacked vegetation cover. The availability of modern equipment for ploughing and tilling has increased the deforestation. Agriculture as the main factor behind deforestation has been confirmed by Kaplan *et al.* (2009) who studied the deforestation processes in Europe from prehistoric times to industrialisation.

The need of house also changed the pattern by which humans used soil and timber. They usually brought materials from floodplains, river terraces and also from rivers. Deforestation increased because of the need for timber. Similarly, the use of sand and gravel as construction materials changed natural rate of river sedimentation. The extraction of huge quantities of sand and gravel in the lower parts of a river by crusher industries increases the erosion brought about the river in the upper parts. The need of land for construction of houses and availability of modern equipment has also increased the trend of carving hillocks or flattening the raised landforms, especially in the urban areas. Constructions in the floodplains of rivers and streams have reduced their width, changed their courses or have ceased their flow.

Photo 1 Human induced mass movement of a hillock at Chandol, Kathmandu in 2016

Photo 2 Flattening and scraping of the hillock in Photo 1 in 2017

Quarrying of rocks such as granite, marble, slate, phyllite, limestone, etc. for construction and surface and underground mining can change the landform in which they are found. The removal of overburden, tunnelling and caving, change the natural landform and even landscape of the quarry or mining site. Modern technology and equipment have made mining easier, thus increasing the rate at which humans can modify the landforms and increase soil erosion and mass movement.

Modern technologies and equipment have not assisted humans in destroying landforms but also in the creation of man-made landforms. Humans have created artificial islands to increase the area of the land they rule upon. The construction of islands such Palm Islands can be taken as the encroachment of the sea and its effects are visible on the coasts. However, humans have also been able to create artificial habitat for corals helping improve biodiversity.

4. MAGNITUDE OF EFFECTS ON SEDIMENTATION, SEDIMENT TRANSPORT AND GEOMORPHOLOGY

By the beginning of the 21st century, humans have become important geomorphic agents. They have sculpted landscapes, with exponentially increasing rates of mass movements of different types. Hooke *et al.* (2012) have estimated that >50% of Earth's ice-free land area has been directly modified by humans by moving earth or changing sediment fluxes. Human activities such as the use of machinery, industrial production of air pollutants, and human-induced global warming have directly as well as indirectly influenced the rate of ocean rise. Some islands of the Maldives, the Indonesian Archipelago and some coastal areas have submerged into the oceans. Many coastal areas are in the risk of drowning. Global warming has also increased the risks of glacial lake outburst which can bring about floods in rivers of countries like Nepal, also changing the geomorphology as well as the rate of sediment transport.

Humans have influenced the ways by which geological processes occur which in turn have led to the change in landforms. Human activities have changed the rate of sediment transportation and also have reconfigured topography. According to Wohl (2013), the sediment transport by the rivers has increased globally through soil erosion (by 2.3×10^9 metric tonnes/y), but decreased the sediment flux to the oceans (by 1.4×10^9 metric tonnes/y). This is because of the storage of sediments in reservoirs. Reservoirs around the world, store >100 billion metric tonnes of sediment (Syvitski *et al.*, 2005).

Human activities have altered rivers. Over half of the world's large river systems are affected by dams (Nilsson *et al.*, 2005). Almost all rivers are somewhat affected by dams, levees, channelization, and flow diversion, as well as chemical pollutants in water, sediment and solute yields from the adjacent uplands (Wohl, 2004, 2011). Dams have resulted in the extensive control of river flow. This has a direct influence on the sediment transport and influx.

5. FUTURE IMPACT ON SEDIMENTOLOGY AND GEOMORPHOLOGY

The increased use of technology and gradual evolution of modern equipment is going to continue the influence on the sedimentology and geomorphology. Humans will have control over most of the parts of the land and they will influence the seas. It is certain that humans will have control over mountains and seas. The rate of mass movement will increase as more mountains will be flattened. If the construction activities over streams continue, they will continue changing their course or will cease flowing at all. The construction of dams for energy and irrigation will increase because of which the sediment stored in the dams. Mining will increase as better equipment will be able to extract minerals more economically from deep-seated or currently inaccessible mines. With the increase in human activities and their use of machinery, the influence on sedimentation and geomorphology is also going to increase proportionately.

6. CONCLUSION

Humans have been influential in changing the face of the earth since they developed

agriculture for sustenance. The development of different types of equipment after the industrial revolution changed the course of humanity forever. This established direct as well as the indirect influence of humans upon the landforms and landscapes. Humans are definitely going to increase their effects on the earth as the technology will evolve. The evolving technology is also going be used for conservation of landforms, landscapes, biodiversity and available resources.

ACKNOWLEDGEMENT

I'd like to thank my parents and my friends who assisted me to complete this report with as little error as possible. I'd like to express my special gratitude to Dr Tara Nidhi Bhattarai for granting the opportunity to publish an article related to the knowledge of geology I garnered in these four years. I'd also like to acknowledge to my teachers of Tri-Chandra Multiple College whose guidance was golden in writing the article.

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About the Author of *Effect of Human Activities on Sedimentology and Geomorphology*

Year of Admission: 2070 B.S.

Name: Ankit Dhakal

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Subject Combination: Geology, Botany, Zoology

I opened my eyes twenty-two-and-a-half years ago at Patan Hospital. Two years later, my parents shifted to Pragati Tole, Dhumbarahi, Kathmandu and since then I have been living with my parents and my little sister, in this locality. I passed my SLC from Universal Higher Secondary School, Dhumbarahi and then for the next two years, I joined Liverpool Higher Secondary School, Baneshwar. I joined Tri-Chandra College so that I would not lose a year while preparing for medical entrance but I ceased taking the medical entrance to devote myself completely to the subjects I had chosen to study.

I love reading both fiction and non-fiction. In fiction, I like mostly the short stories that fall under crime, thriller and fantasy genres. In crime and thriller genre, my favourite authors (books) are Sir Arthur Conan Doyle *(Sherlock Holmes)*, Agatha Christie *(They Went to Bagdad, The Mysterious Affair at Styles, The Secret Adversary, etc.)*, Edgar Allan Poe *(Short Stories- The Black Cat, The Oval Portrait, The Tell-Tale Heart, etc.)* and Dan Brown (*Digital Fortress, Robert Langdon Series)*. In the fantasy genre, I love the work the works of J.R.R. Tolkien *(The Hobbit, The Lord of the Rings, etc.)*, J.K. Rowling *(Harry Potter series)* and G.R.R. Martin *(A Song of Ice and Fire aka Game of Thrones series)*. *Ghanachakkar* by Sanjeev Upreti, *Karnali Blues* by Buddhisagar and *Sumnima* by B.P. Koirala are my favourite Nepali novels.

In non-fiction, I love history, essays and biographies. I have gone through Editor Daniel Wright *(History of Nepal)*, and some books of the Mahesh Chandra Regmi series. I also love the essays of Bhairav Aryal *(Jaya Bhundi, Itishree, etc.)*, Nagendra Raj Sharma *(Benaras ma Bechieki Bahini)* and Laxmi Prasad Devkota *(Laxmi Nibandha Sangraha).*

Writing is an outlet for my thoughts and introverted nature. That's why I love writing blogs. I have set up blog sites: Sanskrit Epics-History or myth? (http://sanskrit-epics-history-or-myth.blogspot.com), where I questioned some aspects of Hindu epics and stories, and Stories of Sandeept (http://storiesofsandeept.wordpress.com), where I publish short stories, poems and personal essays. I have also planned on setting up a blog site (or a website, if affordable) related to Geology.

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EXPANSION OF ROADS IN NEPAL

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Abstract:

The road is the prerequisites for the development of the country like Nepal but the construction of the road in the rocky terrain of the mountains and the hills of Nepal is challenging. The geology and the geography of the country have become the impediment for the road construction in Nepal. Being a landlocked country, there is no any probability of water transport. Land topography, high mountains including the world's largest are the hindrance for the airways which can't be affordable to every people of the country. So, the road is only the accessible and the cheapest means of transportation. But in the name of development roads are being expanded without analyzing its impacts. Lack of place for engineering geologist in the Department of Road of Nepal and insufficient required equipment has led difficulty for the sustainable development of roads.

Key Words: *Road, Construction, Development, Engineering geologist, Sustainable*

1. INTRODUCTION

The road is the essential requirement for the movement of people from one place to another which is regarded as the backbone for the economic development of the country. If the every nook and corner of the country get linked through roads and accessible for every people it will definitely contribute to increasing the GDP of the country. But the ongoing cumbersome and disproportional road expansion project certainly lead to various serious problems in near future as the concerning authorities are busy on finishing budget rather than working on its sustainability. The road expansion project is mushrooming in various parts of the country without the proper research and analysis that it can invite many hazards. So, engineering geologists and geotechnical engineers can play vital role for the improvement of such projects, but they are ignored by the nation in the important place by Department of Road, Ministry of Environment, Ministry of Forest, and Ministry of Soil Conservation (Paudyal 2016).

2. OBJECTIVES

- To know about the present condition of roads in Nepal
- To analyze the direct impact of the ongoing road extension projects in the different parts of the country
- To find out the possible measure to control haphazardly construction
- To find the effective eco- friendly way of construction

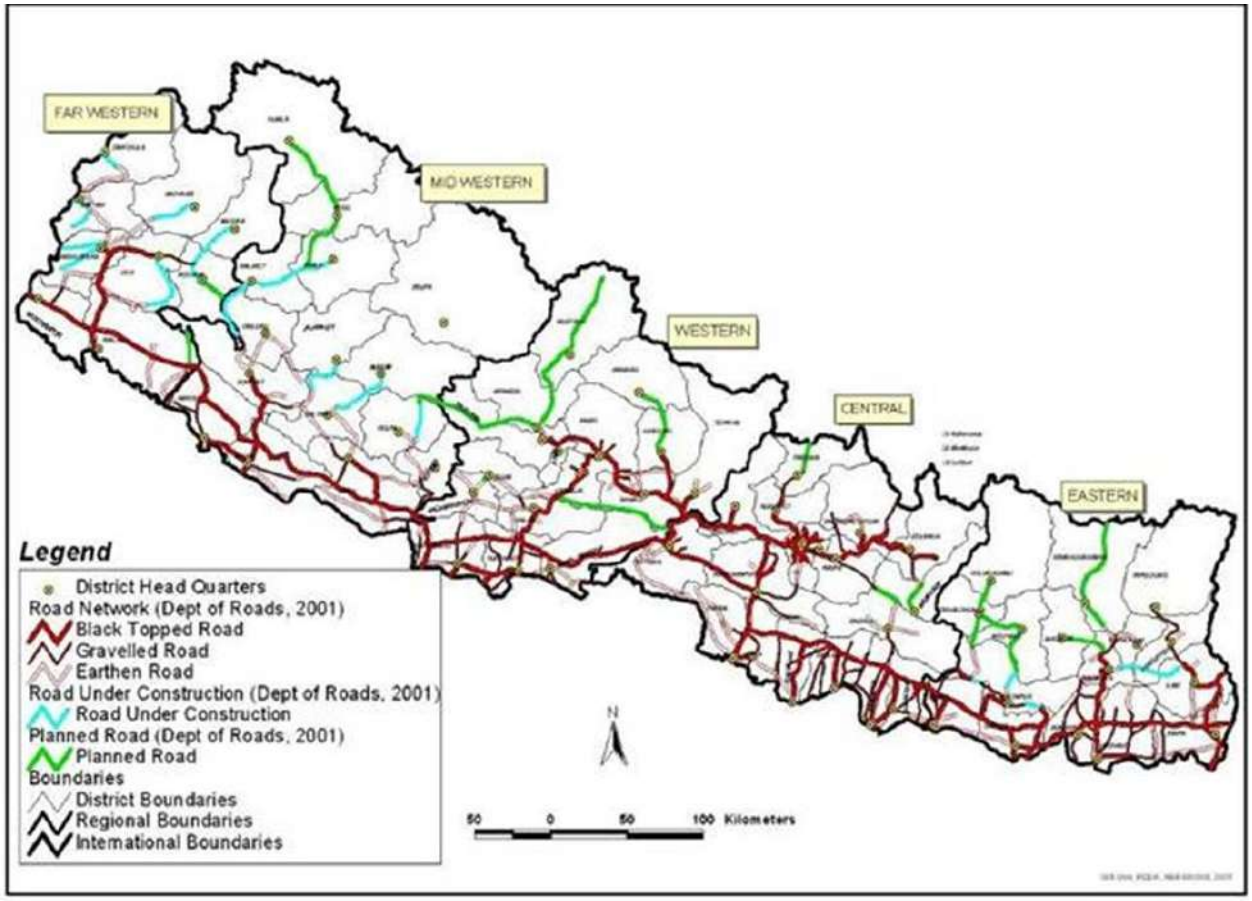

Fig. Nepal Road Network[Online]

3. METHODOLOGY

Different articles and published reports on the related topic were studied. The direct observation of the site of such road projects was done. Much information is collected from the internet also.

Interactions with some people of some site that was accessible to me were also done.

4. FIELD INVESTIGATION AND DATA COLLECTION

This article doesn't contain any specific site of the study. It is based on the observation of mine during travelling in public transport inside the Kathmandu valley and Pasang Lhamu Road and Galchhi-Trishuli road.

5. RESULTS AND DISCUSSION

The present status of the road inside the Kathmandu valley is worse. The pace of extension and improvement work is going like a snail. Dust pollution has become the major issue of the town due to which people are suffering from irritation, respiratory disorder, stress, eye problems, etc.

Fig.1 Cutting material is thrown down slope (Pasang Lhamu Highway)

Being the capital of the country, roads of Kathmandu have the worst situation, what would be the situation of the roads outside the valley and the rural roads of the country? We can't even imagine. Government and concerned authorities are showing different problems like limited time as monsoon is approaching, budget problems so the improvement work is delaying. And in many parts debris flows, rock falls, and dry landslides are the major problem before the monsoon. As we all are known about the Narayangarh-Muglin road how it has been affected due to the complexity in the geology of the area. Thousands of people travelling through this road are being affected by traffic congestion and compelled to wait for long hours. On the Pasang Lhamu Highway the road extension project is going on, in the previous year many small-scale landslides have occurred there and nowadays I have seen the loose material of the hill slope that has been cut is thrown to the down slope that has affected the vegetation and becomes the causative agent for landslide in the dry season. The rocks excavated from the site are sold by the contractor according to the local people. Sometimes the work gets disturbed due to the protest of the local people because they want the compensation or the property in the safe place. Due to the road extension in some section, the houses are at of high risk of landslide. Many people have become homeless and don't get compensation as well. The widening of the narrow roads of rocky terrain has affected the stability of the slope. There is no guarantee of the safety of life while travelling on the roads of Nepal. For instance, in the Galchhi-Trishuli road, near the place called Kolputar huge block of rock is ready to fall that may harm anyone travelling there. But no any efforts have been made to prevent or to throw it away because it has fragile terrain. The earthquake or the mass triggering may cause the fall of

it. The widening of the roads has increased vulnerability.

Rockfall, slope failure, debris flow, landslide are the major mass movements caused by the extension of roads.

Recommendation

We don't want to have bumpy rides but the adverse effects that may cause due to the expansion of the roads should be analyzed and proper planning should be done. Environment Impact Assessment should be done and engineering geologist and geotechnical engineers must be appointed for the conduction of such projects.

CONCLUSION

Road extension and improvement projects are running haphazardly leaving behind various problems. The risk of mass movement like landslide, Rockfall, slope unstable, debris flow is maximizing with the enlargement of road networks in the rocky terrain of hills and mountains. Various health problems have seen in the people of Kathmandu valley with the road extension creating dust pollution and many people of the hills have been affected because of the loss of their homes and property. The government should work on the sustainable development of the roads.

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I express my sincere gratitude to all the lecturers of Department of Geology.Sincere thanks and heartfelt gratitude goes to Dr Tara Nidhi Bhattarai for his constant guidance, creative suggestions and encouragement to write. I am thankful to the editorial board of the magazine and the friends for their support and encouragement.

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About the Author of *Expansion of Roads in Nepal*

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I was born in Bidur municipality, ward no.4 Nuwakot. I completed my schooling from Shree J.D Boarding School, Bidur-6, Nuwakot. After the completion of SLC in 2067 B.S., I moved to Kathmandu for joining Science stream and completed my +2 education from Morgan International College, Basundhara. I have thought of joining B.Sc. Environment in the beginning until I don't have any idea about Geology. Later on, I get the idea about the subject Geology and its scope from my brother-in-law and I changed my mind and get admitted in B.Sc. Geology and from that day I set up my mind to study Geology as a major subject and make my career in this field. I was enchanted by the Ranipokhari and Ghantaghar that I haven't seen so closely before. I still remember the very first day of Tri-Chandra Campus, the exhilaration with which I have entered the gate of college turned awful when I entered the classroom, I had never imagined there would be so much crowd. I had thought there would be a separate class for each subject combination but I was wrong. I felt awkward in beginning days, new faces and totally new environment but I was allured by the Geology class. Although it is the department of the same college, it is entirely distinct from the rest. However, there was a crowd of students it was quite too. When I look back to the 1st year class, one of the most memorable moments is when I used to attend the Physics class to get a seat in the classroom which was not in my subject combination. The interaction, cooperation and discussions with friends for doing practicals are the most cherishing moment at Tri-Chandra Campus. In the 1st year course, I enjoyed studying Physical Geology and Paleontology. The concept filled on my mind by seniors that Government College doesn't have any proper management, laboratory, rules and regulations; Department of Geology has proven it wrong. The well-managed schedule of laboratory and learning was the best part of the study. In 2nd year I found Structural Geology and Petrology interesting which have developed curiosity on me to identify the rocks and structures that we get contact in our daily life that used to be neglected before. In 3rd year course, Stratigraphy, Geology of Nepal Himalaya and 14 days long geological tour in Malekhu have developed the passion of being a geologist in near future. And in the 4th year, Engineering geology and Hydrogeology are the favourite subjects of mine which are the essentials in the context of Nepal for the rapid development.

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EARTHQUAKE: ITS IMPACTS AND METHODS TO REDUCE ITS IMPACTS IN NEPAL

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Abstract:
Earthquake is natural devastating force; it can destroy manmade structure by shaking and displacement of ground. Nepal is often victim to natural disasters such as landslide and earthquake. Earthquake can trigger landslide and floods in case of Nepal. This article is about earthquake, its impacts and measures to minimize its impact in case of Nepal.
Nepal, which lies in the Himalayan range, is one the most vulnerable places for earthquake due to the ongoing mountain building process. Because of this reason and as a victim of devastating Gorkha earthquake-2015, I am interested to this subject for research.

Key Words: *Earthquake, Devastating, vulnerable, Hazard Maps*

1. BACKGROUND

An earthquake is the shaking of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. It is also known as a quake, tremor or temblor. It is a Natural phenomenon which is the most powerful and devastating. Earthquakes are caused by the release of built-up stress within rocks along geologic faults or by the movement of magma in volcanic areas. They are usually followed by aftershocks. There are four different types of earthquakes: Tectonic, volcanic, collapse and explosion.

- A tectonic earthquake is one that occurs when the earth's crust breaks due to geological forces on rocks and adjoining plates that cause physical and chemical changes.
- A volcanic earthquake is any earthquake that results from tectonic forces which occur in conjunction with volcanic activity.
- Collapse earthquake are small earthquakes in underground caverns and mines that are caused by seismic waves produced from the explosion of rock on the surface.
- An explosion earthquake is an earthquake that is the result of the detonation of a nuclear and/or chemical device.

2. OBJECTIVES

The main objectives of this article are to understand earthquake, its impacts and the ways to reduce the impact of earthquake in the situation of Nepal.

3. METHODOLOGY

The information and data for this article are collected from secondary sources like; different books, website, journals, research reports and newspapers. I had complied that information and data and summarize it in my article.

4. RESULT AND DISCUSSION

4.1 Impacts of Earthquake

It is the most devastating natural phenomenon so the impact of the earthquake is too much high. Earthquake damage depends on the magnitude of earthquake and hypocenter. Earthquake impact can be study on two board categories i.e. primary effect and secondary effect. Primary effect is the direct shaking effects as damage or collapse of buildings, bridges, elevated roads, railways, water towers, water treatment facilities, utility lines, pipelines, electrical

generating facilities and transformer stations and the secondary effects that are caused by earthquakes, most often a result of strong shaking, such as landslides, soil liquefaction, fires, floods etc. have also played an important role in destruction produced by earthquakes. These effects mean short-term (immediate) or long-term impacts. Depending on the vulnerability of the affected community, large numbers of people may be homeless due to an earthquake.

4.2 Earthquake in Nepal

Nepal is a seismic prone country and the risk it faces from earthquakes is very high. The main reason behind earthquake in Nepal is that 45 million years ago, the Indian continent collided into Southern Tibet. The Indian continent is driven under Tibet, pushing lightweight sediments upwards and thus the formation of the Himalayas. Nepal sits across the boundary between India and southern Tibet which are still moving towards each other by 2 meters per century. This movement creates pressure within the Earth, which builds up and can only be released through earthquakes. This is the only way earthquakes happen in Nepal. Past records have shown that Nepal can expect two earthquakes of magnitude 7.5-8 on the Richter scale every forty years and one earthquake of magnitude of 8+ in Richter scale every eighty years. According to research there are around 92 fault lines which results earthquake in Nepal. And also in the list of most danger country of earthquake, Nepal is in the 11th position as well as the city in which there will be more human casualties, Nepal is in 1st position. The historical high magnitude earthquake in Nepal from 1300 AD to 2015 AD is tabulated below.

Table 1 Historical high-magnitude earthquakes in Nepal (1300AD- 2015AD)

Date	Time(NST)	Place	Latitude	Longitude	Fatalities	Magnitude
1344		Mechi	27.5	87.5	100	7.9
1408 august		Bagmati	27.9	86.0	2,500	8.2
6 June 1505		Karnali	29.5	83.0	6,000	8.8
January, 1681		Koshi	27.6	87.1	4,500	8.0
July, 1767		Bagmati	28.0	85.5	4,000	7.9
26 Aug,1833		Bagmati	27.9	85.5	6,500	8.0
7 July, 1869		Kathmandu	27.7	85.3	750	6.5
28 Aug, 1926	06:39	Nepal/Tibet	30.0	81.0	3,500	7.7
15 Jan,1934	08:43	Nepal/India	26.773	86.762	8,519	8.4
27 June 1966	10:41	Nepal/India	29.554	80.854	80	6.3
29 July,1980	14:58	Nepal	29.598	81.092	200	6.5
20 Aug,1988	23:09	Nepal/India	26.775	86.616	1,091	6.6
18 Sept, 2011	06:29	Sikkim	27.33	88.62	111	6.9
25 April,2015	11:56	Nepal	28.147	84.708	8,922	7.8
12 May, 2015	12:38	Nepal/Tibet	27.97	85.96	213	7.3

4.3 Gorkha Earthquake -2015 and Its Impact in Nepal

On April 25, 2015 11:56AM local time, 7.9(Mw) Richter scale earthquake made the scene of heart chilling. Thousands of people died, many children have been orphaned and thousands of people became homeless. Out of 75 districts, 30 districts in Nepal have been affected with the earthquake. The Earthquake epicenter was at Barpak, Gorkha about 38 km away from Kathmandu. For the first time since 1934 so ragged intensity earthquake occurred in Nepal, which caused more than 8,500 deaths and more than 20,000 injures. Again A series of powerful aftershocks shake in daily and a major aftershock occurred on 12 May 2015 at 12:50 NST with a moment magnitude (Mw) of 7.3. The epicenter was near the Chinese border between the capital of Kathmandu and Mt. Everest. More than 200 people were killed and over 2,500 were injured by this aftershock. The location, magnitude, and focal mechanism of the earthquake suggest that it was caused by a slip along the Main Frontal Thrust. Earthquakes in China, India, Bangladesh and Pakistan were also mirrored in.

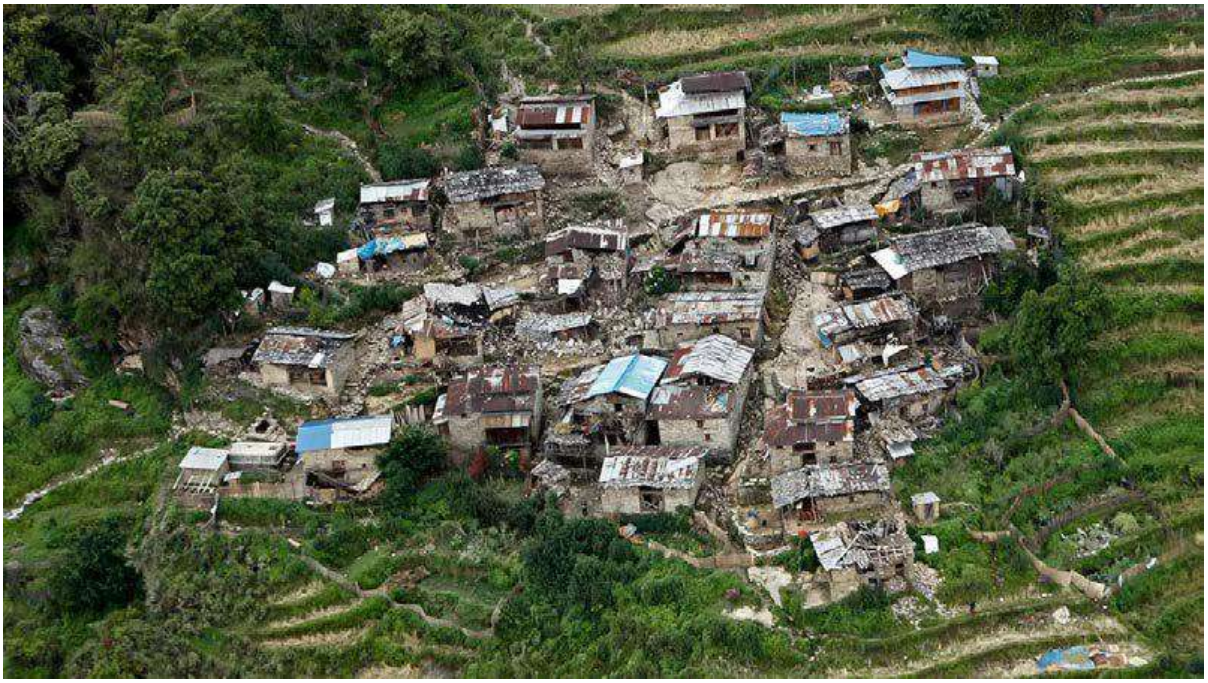

Figure: Damage by devastating Gorkha Earthquake-2015 in Nepal (Source: abc30.com)

The earthquake has affected environment, socio-culture and economy of Nepal. The earthquake destroyed many important ancient historical temples and other buildings have encountered. Nepal faced high damage in economy due to damage of buildings, schools roads, temples, cultural and world heritage sites along with cattle and stored food & crops. More than 4,000 landslides were occurred due to the Gorkha earthquake. It also caused the scarcity of water due to fluctuations of ground water. The earthquake created the many problems and caused psychological trauma. Many people were compelled to live outside in the tents and open sky for many days to month including children and girls putting them in an especial vulnerable position. There have been reports on trafficking of woman and children. Also Nepal faced problem in tourism and business sector. According to the geological survey from US, the sum of economic losses in all sector estimated near to be $10 billion.

4.4 Methods to Reduce the Impacts of Earthquake

Nepal is the landlocked country which is in developing phase. As a developing country, roads, hydropower, building, etc. are on construction. These should be earthquake resistant. The Gorkha Earthquake also gave us lesson to reduce the impact of earthquake. Impacts can be reduced by following certain procedures in Nepal.

- Awareness about earthquake and its impacts
- Interpreting recorded ground motions
- Seismic Hazards Maps
- Construct Earthquake resistance infrastructures.
- Measures adoption of zoning, land-use practices, and building codes
- Emergency plan about hazard
- Earthquake drill
- Government policies about disaster risks adaptation, preparedness & management.

Many seismologists have said that "Earthquakes don't kill people, buildings do". This is because most deaths from earthquakes are caused by buildings or other human construction falling down during an earthquake. So Earthquake resistance infrastructures, hazards maps, building codes, awareness, education, preparedness, and prediction and warning systems can reduce the disruptive impacts of Earthquake on communities. Avoiding development in landslide- and flood-prone areas through planning and zoning ordinances can be reduced the impacts of earthquake. To mitigate impact of earthquake, socio-economic and political barriers should be avoided on newly constructing infrastructures. So, government should launch awareness programs, Seismic Hazards maps and disaster risk management programs regarding the measures to reduce the impact of earthquake.

5. CONCLUSION

Earthquake is natural phenomena. It can't be predicated and prevented but its impacts can be minimized. Many people are aware about impacts of earthquake and they believe impact can be minimized if effective measures carried out. Geologist frequently suggested that Nepal would have greater loss of lives in every earthquake like Gorkha Earthquake-2015 due to the neglecting the geological criteria and unplanned construction. The lesson learn from Gorkha Earthquake, we are in sensitive place where a natural phenomena Earthquake can regularly hit so we must have preparedness and capacity to coping the situation to minimize the impact of earthquake.

ACKNOWLEDGEMENT

Firstly, I would like to thank to Head of Department of Geology, Tri-Chandra Multiple Campus, Ghantaghar, Kathmandu and Respected sir Dr. Tara Nidhi Bhattarai, who gave me the opportunity to know about geology and write this article. I would also like to express my gratitude towards my friend Prakash Malla for helping me prepare this article.

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About the Author of *Earthquake: Its Impacts and Methods to Reduce Its Impacts in Nepal*

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I was born in Gajuri Gaupalika-8, Prawang, Dhading, Nepal. I passed S.L.C from Shree Kiranchok Secondary School, Prawang and completed +2 from Kumari English Boarding Higher Secondary School, Boudha. After completing Intermediate level, I entered Tri-chandra Multiple Campus for further studies and chose Geology as my major subject in Bachelor Level as I heard it has a very bright scope in Nepal and international engineering field. At the starting class days, I was impressed by the lecture of Dr. Tara Nidhi Bhattarai and other respected teachers then I realized that I am in right place to built career.

I love adventure, social work, photography and literature. "Mother" written by Maxim Gorky in 1906 is one of the favourite novels of mine. It gives the detail ideas about Russian Revolution of the 18th century. Similarly, the best book I have read, by Nepali authors is "Karnali Blues" written by Buddisagar published by Fineprint Publication is. It wonderfully portrays the father-son relationship.

The knowledge and wisdom that I have gained during my school days has encouraged me to make a commitment that there is nothing important than helping others.

During the beginning class days of geology, I was a regular student and used to carefully listen to the teachers. I paid good attention to the geology class but I could not be regular in classes after second year due of my household problems.

Studying Geology in third year and fourth year was even more fascinating because of fieldworks. During third year field work, geological mappings attracted me a lot. It was an indispensable tool to know about the types of rocks and geological structures are changing horizontally and vertically in an area. In fourth year I loved to prepare landslide maps and engineering geological maps. This has played an important role not only to understand natural process that occurred in the past and presently prevailing now but also to design various infrastructures in an environmental friendly manner.

Considering the facts mentioned above and also based on my own wisdom, I intend to be a geologist in future and prove to be a good one within 10 years. I want to begin different researches that are yet to be started in Nepal related to engineering geology.

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EARTHQUAKE AND STRUCTURAL DAMAGE

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ABSTRACT

The 2015 Gorkha earthquake spread damage and devastation throughout Nepal. The extent of the damage was highly dependent on underlying geology, building materials, location and level of urbanization. A case study of two sites in the Kathmandu Valley, Sankhu and Asan, focuses on the damage sustained by similarly constructed load bearing structures, also known as structures without reinforced rebar and concrete frames. Structures in the more rural village of Sankhu sustained heavier damage than Asan. Structural failure in the form of cracks, partial, and complete collapse were prevalent in Sankhu while in Asan cracks, warping, and structural damage was observed. Recommended courses of action include increased government compliance to building code, demolishing substantially damaged buildings, rebuilding with rebar and concrete frames, and building complexes together at similar heights. These recommendations will ensure that people and property are secure for the next earthquake disaster.

***Key Words**: Gorkha Earthquake, Kathmandu Valley, Damages*

1. BACKGROUND

On April 25, 2015, Nepal was hit by a 7.8-moment magnitude earthquake. The epicentre, located near the city of Gorkha, extended southward toward Kathmandu. However, following the initial earthquake, aftershocks shook Nepal causing further damage. In the aftermath of the earthquake, nearly $10 billion in damage occurred as well as the loss of nearly 9,000 lives. The 2015 Gorkha Earthquake is a striking example of the sheer power and devastation of nature. In this earthquake hazard assessment of the Kathmandu Valley, we focus on comparative analyses of load bearing structures in the towns of Sankhu and Asan. During the earthquake, nearly 100,000 load bearing structures collapsed, injuring and killing citizens. Through a detailed analysis of these two locations, we hope to shed light on the causes of the catastrophic failure experienced by homes, schools and places of work (Figure 1). We hope to develop solutions that will prevent such extreme property damage and loss of lives in the future.

Sankhu is a rural town located at the northeastern edge of the Kathmandu valley. Asan is an urban sprawl located with the limits of central Kathmandu.

Fig. 5 This house experienced extensive damage, as shown by the numerous cracks in the wall. The temporary tin roof can be seen. Also, note the colour difference between the red, kilned bricks in the lower portion and the grey air-dried bricks higher on the wall.

2. METHODS

Initially, air-photos of both Sankhu and Asan to determine relevant geomorphological features that relate to the damaged observed in each respective location were used. Next, each site was visited for roughly 4 hours at a time, taking pictures, speaking to locals, and analyzing the load bearing structures. We made observations of the construction material, location, and structural failure patterns of each load bearing structure. In Sankhu, a stratigraphic sequence of the underlying geology was prepared to aid in our interpretation of the damage. In Asan, this task was not feasible, so instead, the stratigraphic sequence was reviewed. Finally, a Modified Mercalli Intensity Scale (MMIS) number was assigned to the sites based on eye witness reports of the earthquake as well as the structural damage observed

3. FINDINGS

Building damage patterns: In both Sankhu and Asan, building damage was most exemplified in load bearing Garawalla structures. These structures were made of kiln cooked and air dried bricks with mud mortar and no framework support. There was a noticeable difference in the structural capabilities of the cooked versus air dried bricks. Those left to air dry could be identified by their lighter grey colour and their higher tendency to collapse and create holes in structures. Often these structures were covered by tin roofs after upper stories collapsed during or were removed after the earthquake. Cracks and lopsided structures were prevalent. In Sankhu, the wooden windows and door frames held while brick walls collapsed. Many buildings in Sankhu suffered a catastrophic failure and collapsed completely. However, the load bearing buildings of Asan were often structurally damaged and later demolished in favour of concrete frame structures. Asan displayed a city scape with taller, multi floored buildings. Traditional buildings, such as temples, in both locations, were largely unaffected. This is thought to result from sound architecture that more closely followed traditional building methods, such as interlocking corner joints and foundations.After analyzing both locations we assigned a MMIS. Sankhu, experiencing heavily building damage and collapse, was assigned the Severe Level. Most poorly built structures were experienced high collapse

rates. Asan, which experienced heavy shaking and significant structural damage received a Very Strong intensity rating because the damage and collapse in poorly built structures were significantly less than in Sankhu.

Subsurface geology: Sankhu's top most sedimentary layer resides at an elevation of 1380 meters. Bedrock is located 24 meters below at 1356 meters. The subsurface geology of Sankhu indicates a composition of main clay with interbedded lignite. We were unable to observe sections of the column in our study. Therefore, these sections have been left blank or reported as fill (Fig. 2A and B).

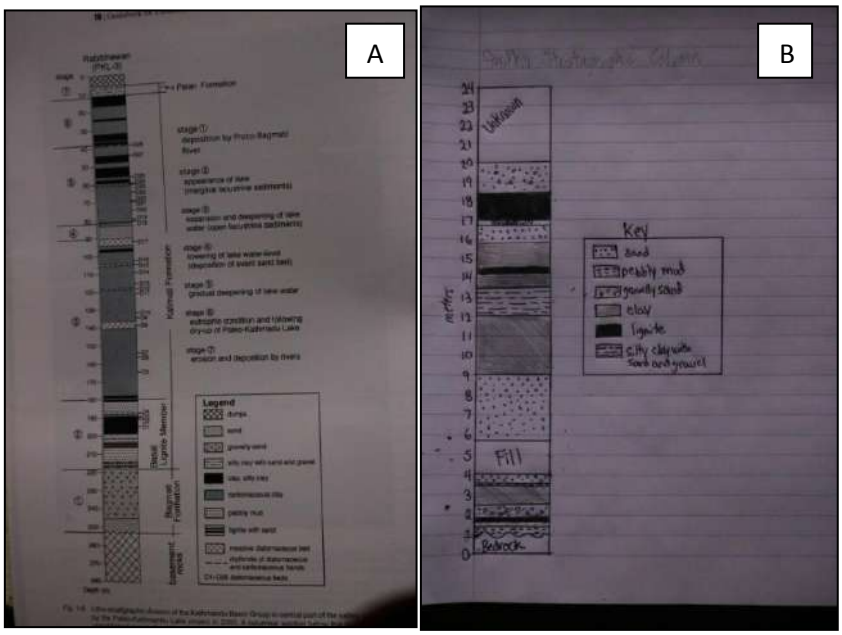

Fig. 2 (A) Asan stratigraphic column taken from Fujii et al. 2012. (B) Sankhu stratigraphic column drawn based on field observations.

Asan is located at an elevation of around 1400 meters. However, bedrock is located 280 meters below at 1120 meters. The stratigraphic sequence is composed of carbonaceous clays and silts. We were unable to observe the geology because of the urbanization of the site but the Guidebook for Excursion on Geology of Kathmandu Valley presents the needed information.

4. ANALYSIS

The differences in subsurface geology have a significant impact on earthquake experience and outcomes. The type of shaking produced in each site was also a major contributing factor to the observed variations in damage patterns. Sankhu is situated on an unstable river terrace composed primarily of clays and lignite. Near the Sali Nadi River, bedrock is located closer to the surface therefore, buildings sustained less damage. Further, from the river, the damage was more extensive because shaking was amplified by loose sedimentary deposits. Asan, on the other hand, is located on nearly 100 meters of silt and carbonaceous clay. When shaking began, Asan experienced motion similar to sloshing a bowl of slush, producing motion that warped and tilted structures as opposed to completely collapsing them. The motion, counterclockwise and clockwise, was observed on GPS and video feed. Damage patterns differed between sites for numerous

reasons. First of all, Sankhu and Asan have structures of different height and density. In Sankhu, load bearing structures were on average 2-3 stories tall and not packed together in tight urban squares. Asan displayed load bearing structures that often reached 3-4 stories tucked in between other structures. The frequency of shaking produced by the earthquake was more damaging to small load bearing buildings as opposed to large ones. Most small buildings displayed some form of cracking or structural damage. However, in Asan, because load bearing buildings were built in close proximity to each other in complexes with frame buildings, they experienced less damage. Today, buildings in Asan are supported by stilts and beams holding them vertically from the ground and laterally against one another (Fig. 3 A, B). Most structures did not completely collapse in Asan but sustained too much damage to remaining livable and were thus demolished. In Sankhu, buildings that sustained significant damage have been repaired with concrete shelling or more bricks. The safety of such structures is questionable.

Fig. 3 (A) Vertical and horizontal beams used to support buildings. (B) Many buildings in Asan are heavily supported by beams.

Uncertainties within our study lie in the exact sub surface geology of Asan and in certain areas of Sankhu because we were unable to directly observe such areas. Also, distinguishing between load and frame structures in Asan was difficult at times due to hidden columns and stucco. Overall, the extent of damage faced by Sankhu was considerably worse due to the height and location of load bearing structures and the underlying geology.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude towards Dr Tara Nidhi Bhattarai for his inspiration and School of International Training (SIT) and Geology department for giving chance to visit the excursion for this report. I would also appreciate the help given by my friends in helping this paper.

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About the Author of *Earthquake and Structural Damage*

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Combination: Geology, Physics and Mathematics

I was born in Kathmandu-10 and raised here. I completed my schooling from Kathmandu Xavier's Public School and passed my intermediate from Himalayan White House International College. I entered Tri-Chandra College for the B.Sc. but still, I was unknown about the subject that should be initiated. Then, one of my senior suggests me to take geology and as per his suggestion, I started taking geology classes. Enthusiasm towards the subject turns out to be my major.

I love spending time by reading books. I have gone through numerous Nepalese books and few foreign books and get really inspired. "Jiban kada ki phool" by Jhamak Ghimire is one of the best books I have gone through. This book inspires me to believe in yourself and your dreams.

Travelling is always fun and geo-fields are always there where you can travel and learn so many things. The field days were so fun and have become one of the best moments of my life. Tri-Chandra College has given me very precious moment in these four years. Apart from my study, I got very good friends to whom I must say they are going to be the best friends of my life.

Currently, I have completed my B.Sc. in geology and I have keen interest working in the geohazards. So most probably, I will be doing engineering geology so that I can have a few roles in the mitigation of the hazards.

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FLUCTUATION OF WATER TABLE, CAUSE AND CONSEQUENCES IN DANG (DEUKHURI) VALLEY

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ABSTRACT
Deukhuri Valley exists in Siwalik region. It is a dun valley. It is located nearly 400 km west of Kathmandu in the Dang district. Population is increasing at an alarming rate. Deforestation and urbanization have consequently increased. About 95% people use groundwater for drinking purpose and other purposes. The water table is found up to 18 ft in some places. There is a good source of aquifer. The proper and sustainable use of ground water helps in the sustainable development of agriculture and livelihood.

Key Words: *Groundwater, Urbanization, Deforestation, Water table*

1. BACKGROUND
In Deukhuri Valley, Rapti River flows through central part of the valley extending from east to west. The climate of this region is tropical climate heavy rainfall takes place during summer season. There was a good number of vegetation al around the hill. The river has largely support for the recharge to ground water and in the other hand Siwalik in itself is a good recharge zone.

2. OBJECTIVE
The objective of this article is to study the present condition of ground water table, the change in water table due to deforestation and urbanization, and its consequences along how can we use and promote it friendly.

3. METHODOLOGY
The article is based on visual study of the localities, previously published articles on newspaper, research articles data analysis.

4. FIELD INVESTIGATION AND DATA COLLECTION
Deukhuri Valley consists of confined and unconfined aquifer. Nearly about 10 years ago, the water in the well was shallow but now days it reaches to the deeper part of the well and some of them are in the verge of drying. The *Jhakhara* wet land has converted to agricultural land. The historical Tapokunda of Rihar is nearly in condition of drying. At Siwalik hill, there were a number of springs but now most of them are vanished. The greenery of the area is decreasing day per day due to deforestation which has directly affect the water table of ground water. The unplanned settlement has been increasing day per day in this valley which will be a complex problem in near future. The forest area is encroaching day per day, the settlement is increasing on foot of Chure hill. The climate has been changing irregular and less rainfall has created the problem of fluctuation. About 80% shallow tube well of *Jhingaha* village reduces its discharge nearly in comparison to rainy season. Nearly 50% area of the valley is irrigated by ground water. Ground water is excessively using but recharge of it is reducing day per day.

5. DISCUSSION
Heavy discharge of groundwater causes the change in water table. The improper and misuse of groundwater causes the shortage of drinking water. The irrigation pattern also gets disturbed, for its proper use sustainable consumption concept should be developed.

The water has directly relationship with human activities, in absence or shortage of this the developmental along human progress is impossible. It has direct impact on the agricultural productivity too. Deforestation is the main problem of Chure for the fluctuation of groundwater. Forest helps in the water holding capacity of soil as well as it controls the fast run off rain-water. Another cause of fluctuation is low precipitation, it directly affects the water table, it is a global problem too. The water table is getting fluctuated in a short interval of day, which affect the drinking and irrigation system. Other negative impacts of deforestation on environment are the lost of greenery, reduction in agricultural productivity and reduction of quality of life. For proper and sustainable use of the forests, of heavy cattle grazing and problem of illegal cutting of timber should be controlled in time. The recharge area can also be maintained by restricting human settlement in such an area.

ACKNOWLEDGEMENT

I am very much grateful to our respected sir Dr. Tara Nidhi Bhattarai and all the teachers of Geology Department, Tri-Chandra Multiple Campus. I also thanks to my all friends, seniors for their valuable suggestion and support.

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About the Author of *Fluctuation of Water Table, Cause and Consequences in Dang (Deukhuri) Valley*

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I was born in Dang (Deukhuri) district. I completed my school education from Buddha Jyoti Higher Secondary School, Dang and +2 from Glorious College, Kalikanagar, Butwal. I got information about geology from my brother who was studying at Tri Chandra campus at that time. The Ghantaghar and well managed Department of Geology attracted me to study B.Sc. in Tri-Chandra College.I still remember my first class of geology taken by our respected sir, Dr Tara Nidhi Bhattarai. The first class of geology motivates me to make a career in geology.

I like travelling in new places. The best book for me till now is *Shirish ko Phool* written by Parijat. It represents real scenario of Nepalese life style. The 14 day field work of Malekhu and 28 days field work of Palpa has helped in learning many more social and academic things. This field work has encouraged me to become a capable and skilled engineering geologist within 10 years.

SECTION B: GEOLOGY IN THE FIELD

This section consists of scientific articles related to:

- Mapping
- Stratigraphy
- Hydrogeology
- Core Drilling
- Landslides

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MAPPING TECHNIQUES FOR EXTENDING LITHOLOGICAL TECHNIQUES

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Abstract

This paper includes the general techniques on extending boundaries of geological formations or any two distinct layers for stratigraphic sequencing. The readers will be given the idea about extension of boundaries and preparation of cross section with conventional method in the topographic map of any scale available. The extension of boundary without the proper field study is hard to be precise but the methods described here provides the base for the field exploration giving the guidance to the explorer for extension of the geological formation and boundaries, preventing the major time loss for random search for the boundaries and stratigraphic sequence.

Key words: Lithological Boundary, Strike Contour Intersection, Attitude, Altitude, Rule of V's

1. BACKGROUND

Mapping is essential element for any geological works. Hence, mapping involves the different objectives for different section of the geology, i.e. engineering maps require the information that supports the engineering analysis, exploration and mining maps consists of the maps of the distribution of specific mineral of interest, hydrogeological map shows the Transmissivity, discharge, water table etc. of the study area, and geological maps accumulate the data for the stratigraphic sequencing and paleogeological analyses.

There are many techniques used for extending boundaries. One of the techniques used for the boundary extension is by borehole logging of various places and the correlation of the lithologies of different boreholes. Another technique is by using geophysical methods for identifying different underlying layers for correlation. Another method is by using grid lines in map to have regular interval of point of inspection. Rule of V's is most common technique used for extension of geological boundaries however, most common mistake is done in this technique is making the V's in wrong direction. There are lots of rules which resemble to one another but are different with the aspects. Therefore, it is quick and easy rule to extend boundary if the rule can be implied correctly else it can destroy the whole map. Rule of V's is fast but it's less accurate in real practice therefore, people need high degree of skill to perform rule of V's. Therefore, strike and contour intersection technique is more reliable as it will guide the point through which boundary passes. But, this method is only applicable when find the outcrop of same bed in different areas to use three point problem for execution. In field excursion, traverse path is predefined so only one point of the boundary is taken for extension. And most of the time rule of V's applied.

But by altering the contour-strike intersection technique, we can extend the boundary in even the scale of topographic map with single point of observation. This method has advantages over rule of V's as it doesn't need to show concern about the degree to tilt the boundary assuming the point of intersection in contour and wrong V's in boundary extension.

2. OBJECTIVES

The main objectives are given below:

- To extend the geological boundaries of the study area
- To make the geological cross section using apparent dip with respect to strike and cross section

3. METHODOLOGY

The primary methodology involves the desk study of different articles and papers written and researched previously (if present). If the place is not studied before, then the nearby correlating papers written are studied for guidance and traverse plan is formulated.

The secondary methodology involves field study. The field observation includes acquiring data like attitude of beds, joints & foliation, altitude of the outcrop and location mostly Global Positioning System, also GPS).

4. FIELD INVESTIGATION AND DATA COLLECTION

The field investigation involves observation of lithological changes or the changes expected by following the reference papers or articles. Without prior knowledge and planning of the field works, people will get little or no idea on performing the field analysis. E.g. On moving south to north on a traverse path of West Central Nepal from Lower Member of Middle Siwalik to Upper Member of Middle Siwalik, we can observe changes in lithological characters that separate the Lower Siwalik with Middle Siwalik, which can be found reference in article of Tokuoka et al. (1986). The observation also includes the finding of Primary Structure like Unconformity and Secondary Structures like faults, folds, thrusts, etc. that separate the boundaries. The presence of highly deformed and rupture zone either with the fault gauges or breccia or mylonite represents the tectonically active area in the field which is also needed to be observed carefully.

With the site investigation, data collection is also an important task to perform. The orientation of beds, joints and foliation along with altitude and GPS location is required for locating the boundaries and extending through appropriate measures. The measure of orientation is done by Brunton compass and the location and altitude is recorded with help of GPS.

The primary step of the field work is the collection of the data (attitude, GPS, altitude of the bed measured) for mapping and is plotted on the topographic map of the area. Then observation of different structures and textures of the certain lithology is done to understand depositional environment and depositional history. Afterwards, the presence of the geological structures like unconformities, ripple marks, cross laminations, faults, thrusts, folds etc. is investigated to understand the influence of the external agents to deform the deposited lithologies and breaks the position of correlated lithologies. If present, thrusts, faults, folds and unconformities are extended primarily by following the slope break point. Slope break point is the point which shows drastic change of slope in topographic map (shown in Fig 4.2). Then the strike is extended with the strike value of the altitude taken (Fig 4.2). Then, the appropriate interval of the strike is taken assuming that the bed is not affected by any external agents. After that the points of same strike with same contour is joined from the point of observation to extend boundary. Then the extended boundary is traversed for correction (mostly needed if the depositional environment is continental environment or the area is in influence of tectonic activities). If the extended boundary is not found aligned with geological boundary in the field, then again numerous data of the bed is taken to get the mean attitude of the bed for extending boundary outwards. The extension of boundary of thrusts, faults, folds and

unconformities are also done in similar manner.

And to add correct dipping in cross section, it's important to consider as well. The cross section can only use the same dip amount for inclination of boundaries only when the cross section becomes perpendicular to strike line. Therefore, most of the time, cross section doesn't go perpendicular to the strike line. So, apparent dip must be used in cross section which can be calculated by following formula:

$$\text{Tan } \alpha = \tan \delta \times \sin \theta$$

Where, α and δ are apparent and true dip, respectively, and

θ is the angle between strike and cross section

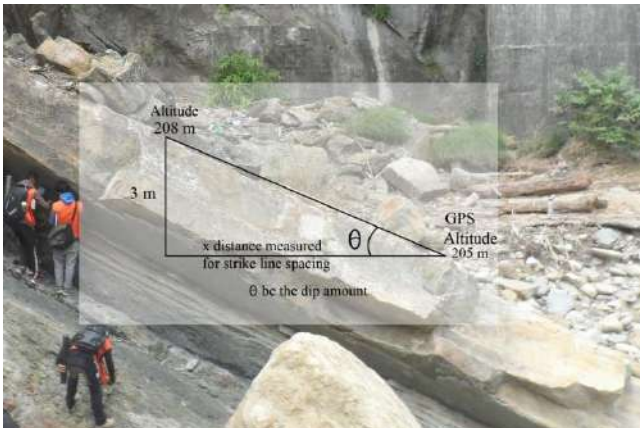
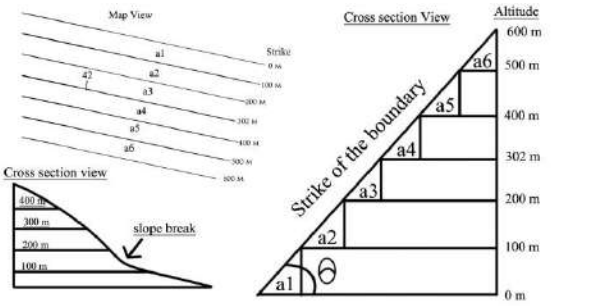


Photo1 showing the technique for measuring the strike spacing distance for topographic map



Here, a1, a2, a3, a4, a5 and a6 are the horizontal spacing between two strikes

Photo 2 showing the imaginary strike extension of the boundary

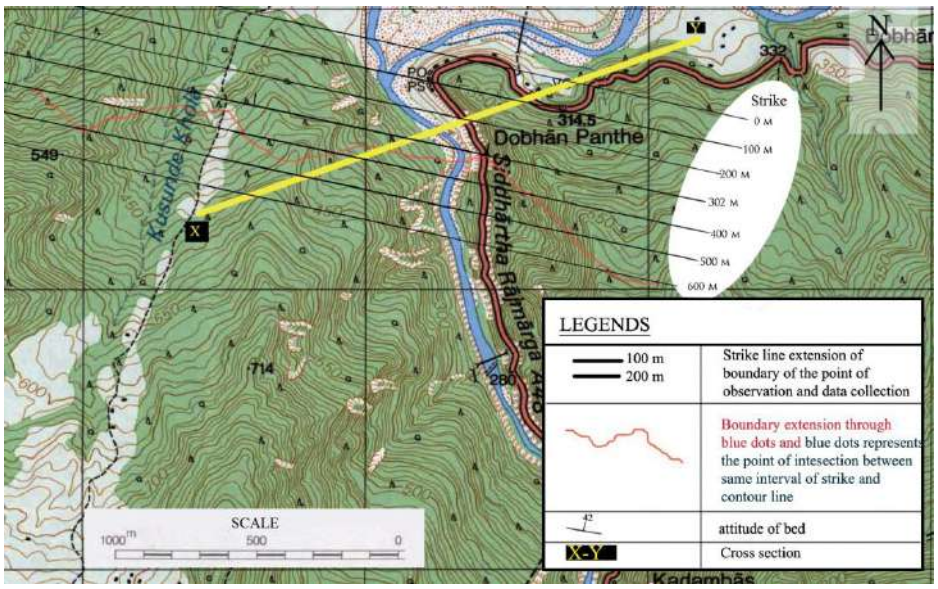


Figure 3 showing the mapping technique for boundary extension

5. RESULTS AND DISCUSSION

The method for boundary extension used in the map is fast and cheap method. After implying the methods, we can get the boundary with correct direction to proceed and extend as per the knowledge assuming the planar boundary. The implication of the techniques also provides proper direction for making the cross section as per the line of

cross section restraining the use of true dip in every condition whether favorable or not. Proper cross section is necessary for the correct interpretation of the map.

However the method is still not perfect to sketch the correct geology. The imperfection in this technique comes from irregular depositional basin, irregular erosion and sedimentation, lack of time and knowledge etc. But still the method provides the basic background on understanding the mapping technique.

6. CONCLUSION

For extension of boundaries the advised method is quite reliable in the field especially when we have limited outcrops and limited time for random analyses. The method mentioned is easy to implement and has advantages over the other techniques on the context of speed, reliability, cost efficiency and other complicated designing. And in context of cross section, the method described helps to make the actual cross section of the field rather than relying on the true dip amount for every case. However, every methods used can provide the nearly same type of boundary extension. But only this method helps even beginners to get idea on boundary extension with little skills of trigonometry without trouble of remembering patterns of rule of V's or travelling with heavy and expensive materials in the field.

ACKNOWLEDGEMENT

I'd like to express my deepest appreciation to all teachers and friends who provided me the possibility to complete this report. I would like to convey my special thanks to Dr. Tara Nidhi Bhattarai for granting me the opportunity to write my ideas and knowledge attained in past four years into the geo-article. Furthermore, I would like to thank Dr. Ananta Prasad Gajurel for listening to my ideas and commenting on the errors, despite having busy schedule. I would also like to acknowledge with greater appreciation, our teachers of Tri-Chandra Multiple College who provided me the guidance in writing the article.

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About the Author of *Mapping Techniques for Extending Lithological Boundaries*

Year of Admission: **2070 B.S.**

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Roll: **351/ 070**

Subject Combination: **Geology, Statistics & Mathematics**

Born in Thankot VDC-2, currently Chandragiri Metropolitan–6, I studied up to secondary level in Thankot English Secondary School, Kathmandu and completed higher secondary level in Himalayan White House International Higher Secondary School, Kathmandu. I love anything related to science. I don't have particular likes and dislikes. Joining geology in Tri Chandra Multiple Campus is one of the great things occurred in my life. I used to have great excitement whenever I used to read anything new about science. I was in grade IX when I first heard about the paleontology which excited me mostly among other part of science. I used to think where in Nepal I could learn about the paleontology. Maybe at that time my fate was bonded to get an opportunity to study that topic.

I occasionally go through the novels whenever I feel free. I got my inspiration for reading novels from my English teacher during higher secondary study. He told me that the best way to improve my English is to read as much novels as I can. Since then I have been through lots of novels. And my first novel was "The Alchemist" which not only gave me the hints to increase my English but also gave me an opportunity to understand what we seek in life. The Alchemist taught me that there will not be better moment than present so I need to cherish every moment fully alongside with the fulfillment of my duties and responsibilities. Then I started reading many novels not to improve my English rather to gain the knowledge about life from different perspective. But lately I'd rather like to develop my own perspective than complicating my mind with different perspective.

I admit that I prefer the knowledge over the education that's maybe my weak point for not securing good marks in exam. But I study not to pass exams but to quench the thirst of knowledge. Classes in Geology were my favorite time of my Bachelor study life. The class used to be well disciplined and used to have good environment for preventing my mind from dwelling into boredom. The only thing I used to hate was to wait hours and hours for taking one class. Indeed patience is also an art but I used to hate waiting which always used to deplete my energy for classes. Maybe that was the reason why I sometimes couldn't understand the teacher's direction. I am not a scholar type so I don't regularly study at home but I used to revise what teacher taught me in class from my own memory. I am not hungry of words but I am hungry of knowledge. The most unforgettable moments in Tri-Chandra College is when I took geology classes which gave me eternal bliss and the most unforgettable gifts given by the Tri-Chandra College are good friends and respectable teachers.

I don't have specific aim but if I were to look myself in coming ten years then I have a faith that I'd find myself enjoying my life with geology.

STUDY OF GEOLOGY OF NEPAL HIMALAYA DURING 6TH STUDENT HIMALAYAN EXERCISE TOUR (SHET), 2017

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Abstract

The Nepal Himalaya is the highest, youngest and very active mountain range evolved due to the collision of Indian plate and Asian plate. The Indian plate drifted northwards to collide with Asian plate forming the Himalaya. The Nepal Himalaya is the central part of the Himalayan Arc covering one-third of its length between Kumaon Himalaya in the west and Sikkim-Bhutan Himalaya in the east. Geographically, about 83% falls within the Mountainous region and the remaining portion lies mostly in the northern edge of the alluvial plains of the Gangetic basin. It is sub-divided into the five major tectonic zones from south to north (**Upreti and Le Fort 1999**): Indo-Gangetic plain (Terai), Sub-Himalaya (Siwalik or Churia Group), Lesser Himalaya, Higher Himalaya and Tibetan-Tethys Zone ranging from Precambrian to Holocene.

This paper describes the Nepal Himalaya based on the field observations along Kali Gandaki River, Pokhara Valley and Tansen-Butwal Area of Nepal.

Keyword: Nepal Himalaya, Precambrian, Holocene, Gangetic Basin, Kumaon Himalayan

1. INTRODUCTION

Every year, a geological field excursion is organized by Institute of Gondawana, Japan in collaboration with Department of Geology, Tribhuvan University to study the geology of Nepal Himalaya and for the study Central west Nepal of Kali Gandaki Valley is selected area of study. The field excursion was of 9 days. There was participation of students from Japan, Nepal and India along with three professors from Japan and Nepal. We travelled along the route: Kathmandu-Pokhara-Muktinath-Pokhara-Tansen-Lumbini-Narayanghat-Kathmandu.

These sites are very suitable to observe all the tectonic zones of Nepal.

From the observation of the study area, an exposure of South Tibetan Detachment system (STDS) was observed which separates Tibetan Tethys sediments and Higher Himalayan Gneiss to the west of Kokhethati village along Chaktan Khola. Similarly, an exposure of Main Central Thrust (MCT) was observed at south of Titar Village which Separates Higher Himalayan Gneiss and Lesser Himalaya Metasediments. An exposure of Main Boundary Thrust (MBT) was observed along Mugling-Narayanghat road across the Narayani Nadhi that separates sedimentary rocks from Lesser Himalaya and Siwalik Sediments. An exposure of Himalayan Frontal Thrust (HFT) was observed along Lumbini-Butwal area that separates Siwalik Sediments from Indo-Gangetic Plain.

The major tectonic subdivisions of the Nepal Himalaya from South to North (Upreti and Le Fort 1999)

Indo-Gangetic Plain

——— **Himalatan Frontal Thrust (HFT)** ———

Sub-Himalaya (Siwalik or Churia Group)

——— **Main Boundary Thrust (MBT)** ———

Lesser Himalaya

——— **Main Central Thrust (MCT)** ———

Higher Himalaya

——— **South Tibetan Detachment system (STDS)** ———

Tibetan-Tethys Himalaya

Besides this, we also studied the geology, evolution and natural hazards related to the Nepal Himalaya. We also get idea about the socio-economic, cultural and life style of Nepalese people who lives in Mountainous area.

Fig 1: Participants of 6th SHET (2017)

2. OBJECTIVES OF THE TOUR

While talking about the main objectives of the tour, it is to observe the geology of Nepal Himalaya but there are some other objectives too and they are listed below:

a) To observe major tectonics zones of Nepal Himalaya.
b) To observe the application of bio-engineering.
c) To study the rock types of all the tectonic zones.
d) To study primary and secondary geological structures like fold, recumbent fault, hummocky stratification and so on.
e) To observe geomorphology of study area.
f) To observe HFT, MBT, MCT, STDS.
g) To study the fossils, glacial and wind deposits in Tibetan Tethys Zone.

3. METHODOLOGY

The field excursion started from March 07, 2017 and ends in March 16, 2017 along Kaligandaki River, Pokhara Valley and Tansen-Butwal area. All along the route, we made stops. We made observations, sketches, interpretation and also took beautiful pictures and all our respect professors shared their expertise on the Himalaya.

4. FIELD OBSERVATION

Major Tectonic Zones of Nepal

- **Indo- Gangetic Plain**

This zone represents the northern edge of the Indo-Gangetic alluvial plain and forms the southernmost tectonic division of Nepal. Physiographically, this zone does not belong to the main body of the Himalaya, it is foreland basin and owes its origin to the rise of Himalaya and thus genetically and tectonically inseparable. Geologically, it is composed of Pleistocene to recent alluvial sediments and the average thickness of alluvium is 1500m. This zone lies in the southern part of the Himalaya, basically composed of the clay to boulder.

This plain makes a gradual up-slope from about 100 m in the south to 200 m in the north near the mountain front. This zone is further divided into three subdivisions:

a. Bhabhar zone

This zone lies adjacent to the foothills of the Churia and extends southward of width about 12 km. This zone is mainly covered by sub-tropical forest and composed of thick sediment zone derived mainly from rocks of the Himalaya. This zone is also known as the recharge zone as it contains highly permeable cobbles, boulders, pebbles and coarse sand (Table 1).

b. Middle Terai zone

This is an intermediate zone between the Bhabhar and the Southern Terai. This is about 10-12km wide. This zone is resulted due to interfingering of two distinctly different facies of sediment along N-S line. Difference in porosity and permeability between the sediments and marked change in elevation has developed spring line, natural ponds and marshy lands along the boundary of two zones.

c. Southern Terai Zone

This zone lies south of the middle Terai zone and extends southward to India - Nepal border. This zone represents typical extensive Gangetic plain. This zone is composed of fine sediments consisting sand, silt and clay.

- **Siwalik (Sub-Himalaya**)

The Siwalik lies in the southern part and represented by low hills. It is bounded to north by the MBT (Fig: 2) and to south by

the MFT (Table 1). It is 30-40 km wide and extends up to 52km. The main lithology is sandstone, shale and conglomerate (derived from higher Himalayas and lesser Himalayas rocks.) The age of the Siwalik is considered to be Miocene. The Siwalik is further divided into three groups:

a. The Lower Siwalik

The Lower Siwalik comprised of finely laminated mudstones, sandstone and siltstone. The main characteristics of mudstone is they are variegated and bioturbated.

b. The Middle Siwalik

The Middle Siwalik is made up of medium- to coarse-grained salt and pepper type sandstones. The pebbly sandstone can be found due to the flood dominated braided river system.

c. The Upper Siwalik

The Upper Siwalik is comprised predominantly of conglomerate and boulder beds with minor proportion of sandstones and mudstones. Hence, the sediments of the Siwalik group are supposed to have come from the lesser Himalaya and the higher Himalaya rocks.

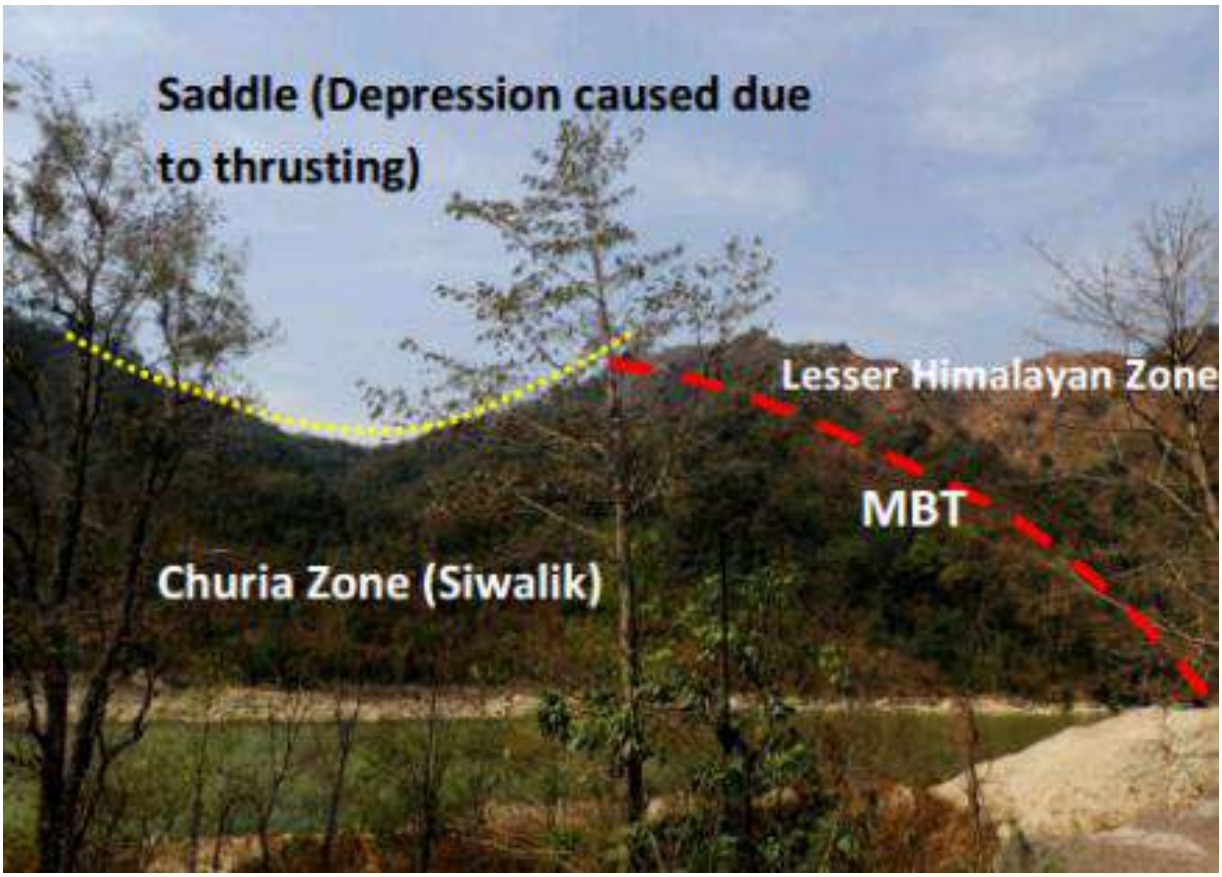

Fig 2 MBT exposure along Mugling-Narayanghat road across the Narayani River (photo taken by Takuma Suzuki from Shimane University)

- **Lesser Himalaya**

This zone lies between the Siwalik and higher Himalayas separated by the MBT (Fig 2) and the MCT (Fig 3). This width ranges from 60-80 km. The zone is made of mostly unfossiliferous sedimentary and

metasedimentary rocks: shale, sandstone, conglomerate, slate, phyllite, schist, quartzite, limestone ranging from the pre-Cambrian to Eocene.

Fig 3 MCT separating Higher Himalaya Gneiss and Lesser Himalaya Metasediments

- **Higher Himalaya**

This zone extends from the MCT (Fig 3) to Tibetan Tethys Zone consists almost 10 km thick succession of crystalline rocks called the Himalaya group. Its northern part is marked by STDS (Fig 4) and base is bounded by the MCT. The crystalline rock of the Higher Himalayan extends continuously along the entire length of the country.

- **Tibetan-Tethys Himalaya**

The Tibetan-Tethys Zone lies about the Higher Himalayan Zone separated by the South Tibetan Detachment System (STDS) (Fig 4), a normal fault and continuous to the north in Tibet. In Nepal, the fossiliferous rocks of the Tibetan- Tethys zone are well developed in the Thak Khola, Manang and Dolpa. This zone is composed of sedimentary rocks ranging in age from lower Paleozoic to Paleocene. The rock exposed at the basal part of the zone shows a higher metamorphic grade and the grades of metamorphism gradually decreases upward and almost disappear at a higher level. The rocks are generally rich in fossils.

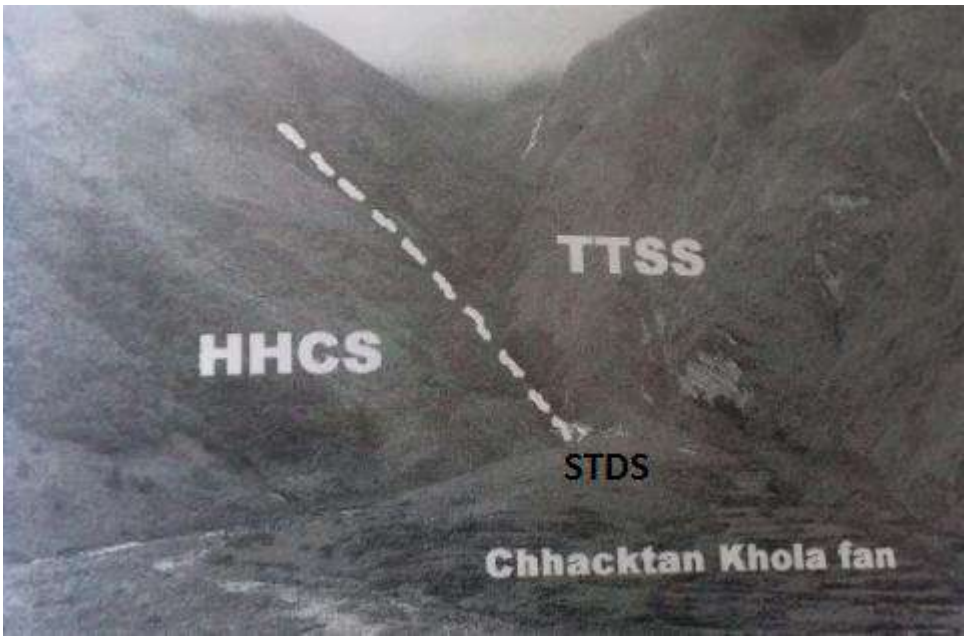

Fig 4 STDS separating Higher Himalaya and Tibetan Tethys Zone (Photo source: Excursion Guidebook, Upreti and Yoshida , 2005)

5. CONCLUSION

Nepal Himalaya is very suitable places for the geologist to study about the geology, geomorphology, paleontology, Natural hazards and so on. Also, during this excursion, I came to know that Nepal is very rich in natural beauty. The views and scenario is very eye catching. I am mesmerized by the beautiful mountains like Annapurna, Dhaulagiri, Macchapuchhre. The most important lesson I have learned along this tour was how to interact with international society and how to adjust with severe conditions especially weather and health condition by being carefully prepared with necessary gears and medicines.

Besides this, The tour was interesting by not only sharing each other's views on geology and field observation but also the socio-cultural interaction among the Japanese, Nepalese and Indian participants. Overall, the exercise tour was very heartwarming and thrilling experience.

ACKNOWLEDGEMENT

Being one among the two Nepalese participants, it was a pleasant experience for me being a part of this tour so I show my sincere gratitude to Mr. Madan Ratna Manandhar, Head of Department of Geology, Tri-Chandra Multiple Campus, Ghantaghar, and Kathmandu for providing me this golden opportunity. Our professors during excursion, Masura Yoshida Sensei, Tetsuya Sakai Sensei and Mukunda Raj Poudel sir were extremely caring and helpful in sharing their expertise o their respective topics. So, I am extremely thankful towards them for being grateful enough to encourage our participation in this tour.

My lovely friends from Japan, Nepal and India showed very kind behaviors towards me throughout the tour. So I am very grateful to them for their co-ordination.

At last but not the least, I am really indebted to my family members for their moral support, love and affection.

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I was born in Chalnakhel-5, Kathmandu. I did my schooling from Kanchan Secondary English School, Lalitpur and completed intermediate (+2) from Moonlight Higher Secondary School (MOHLISS).After my intermediate level I was planning to do Engineering. So During 1st year I was preparing for my engineering exam as well. Later on I found Geology more interesting, So I have decided to built up my career as a researcher of geology and continued my geology From Tri Chandra Multiple Campus.

Habit of reading novels developed within me when I was in class 10. I have gone through many novels until now. Some of the best books I have gone through are 'Seto Dharti' by Amar Neupane. This novel was able to award by the renowned prize 'Madan Puraskar' of 2068. I found this novel very inspirational which mainly which was mainly focused on the psychology of child widow who lost his husband at very young age. 'The Alchemist' by Paulo Coelho is another novel I have gone through till date and one of my favorite novel. This novel is very inspirational where he follows a young Andalusia shepherd in his journey to Egypt, after having a recurring dream of finding treasure there.

At the beginning, joining Tri Chandra was not a happy decision for me. I really struggled with the huge crowds of students. It was challenging to adapt to the environment here. I had never seen such a huge mass of students in a single classroom before. But, eventually with the supportive guidance from my friends, teachers I managed to adapt. I never thought my journey in Tri Chandra could be so fascinating. I was really impressed by the Department of Geology because this department is very far away from the political issues abd unwanted disturbances. I am very happy that I chose to be a student of geology. During My Bsc in Geology I made many sweet and unforgettable memories with my friends and teachers.Real field experiences in every field work helps to enhance my knowledge much better. Field visit during Malekhu and palpa further helps me to grab more knowledge regarding geology and its aspects, knowledge about geological route mapping, its crosss section, geological route

mapping, landside inventory are the major things that we are able to learn during our field visit.

I feel very lucky because I got opportunity to learn geology from excellent teams of teachers of department of geology of Tri Chandra Multiple Campus. I express my sincere gratitude towards all my respected teachers. I aim to be a skilled geologist and I don‘t believe in being a great person but I do believe in being a good person. I am determined to be a good geologist in near future and serve my nation.

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GEOLOGY OF DANG-DEUKHURI VALLEY

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Abstract

This article contains the introduction of Neolithics and Geology of Dang-Deukhuri Valley. The Dang valley is filled up with Pleistocene to Holocene fluvial sediments deposited essentially by north-south flowing rivers. The Dang valley is surrounded by the Siwalik on almost all sides, except for some Lesser Himalaya rocks exposed to the north, at the foot of the Mahabharat ranges. The main Boundary Active fault delimits the valley on the north, and the fault is marked by a conspicuous "pressure ridge" (Nakata et al. 1984). The rocks distributed in the study area are highly deformed. The persistence of shortening between Indian Plate & Asian Plate involves their deformation. This deformation is expressed in the forms of faults & folds succeeding one another in both space and time.

Key words: Neolithics, Pleistocene, Holocene, Siwalik, Pressure Ridge, Deformation

1. BACKGROUND:

The study area consists of two intermontane (dun) valley known as Dang and Deukhuri Valley. The oval Dang valley is about 55 km long and 18 km wide. On the other hand, the Deukhuri Valley is about 50 km long in the east-west direction & about 12 km wide in the central part. It is like an elongated trough containing the Plio-Pleistocene deposits of the Rapti river. It is lying between the Himalaya Frontal Thrust in the south & the Main Boundary Thrust in the north in the Inner Terai region of West Nepal. The Active Fault generally shows a downthrown hanging wall, representing a normal sense of movement and there are several sag ponds that are sometimes filled up with clay and peat. The pressure ridge comprises strongly deformed fluvial deposits, mixed up with various crush rocks from the Siwalik as well as the Lesser Himalaya.

The Churia range is considered very ancient particularly as the home of our ancestors. It is argued that the Ramapithecus, a link between man & ape, apparently live here. This range provided him with a suitable climatic condition. In 1982 the Geologists came to the conclusion that the early hominid group preferred to live in & around the Siwalik range of Nepal. Thus the Siwalik range has been considered as the home of the early man probably from the early stage of human evolution. The Siwalik (Churiya) belt of Dang is the same belt, where the fossilized form of the early human ancestors, the Ramapithecus was found at the Butwal Siwalik range.

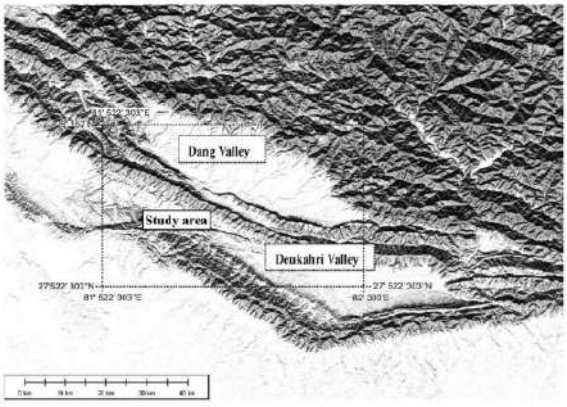

Fig 1: The physiographic map of study area.

2. OBJECTIVES:

The main objectives are to observe & gather the information of the Neolithics & Geology of Dang-Deukhuri Valley. In general, the objectives are:

- To observe fossils & sediments deposits.
- To study the geological structures: faults, folds, joints & sedimentary structures.
- To study the Archeological remains of the Dang Valley.
- To study lithostratigraphy of Dang-Deukhuri Valley.

3. METHODOLOGY:

To complete this articles, all the data & information are taken from secondary sources like books, magazines, articles related to this topic, websites, etc.

4. FIELD INVESTIGATION & DATA COLLECTION:

Lithostratigraphy of the succession consists of the Bankas Formation, Chor Khola Formation, Surai Khola Formation, Dobata Formation & Dhan Khola Formation in an ascending order. The Bankas Formation is represented by an interbedding of red purple mudstones, shales & fine to very fine-grained sandstones. The Chor Khola Formation shows a gradual increase of sandstones grain sizes as well as

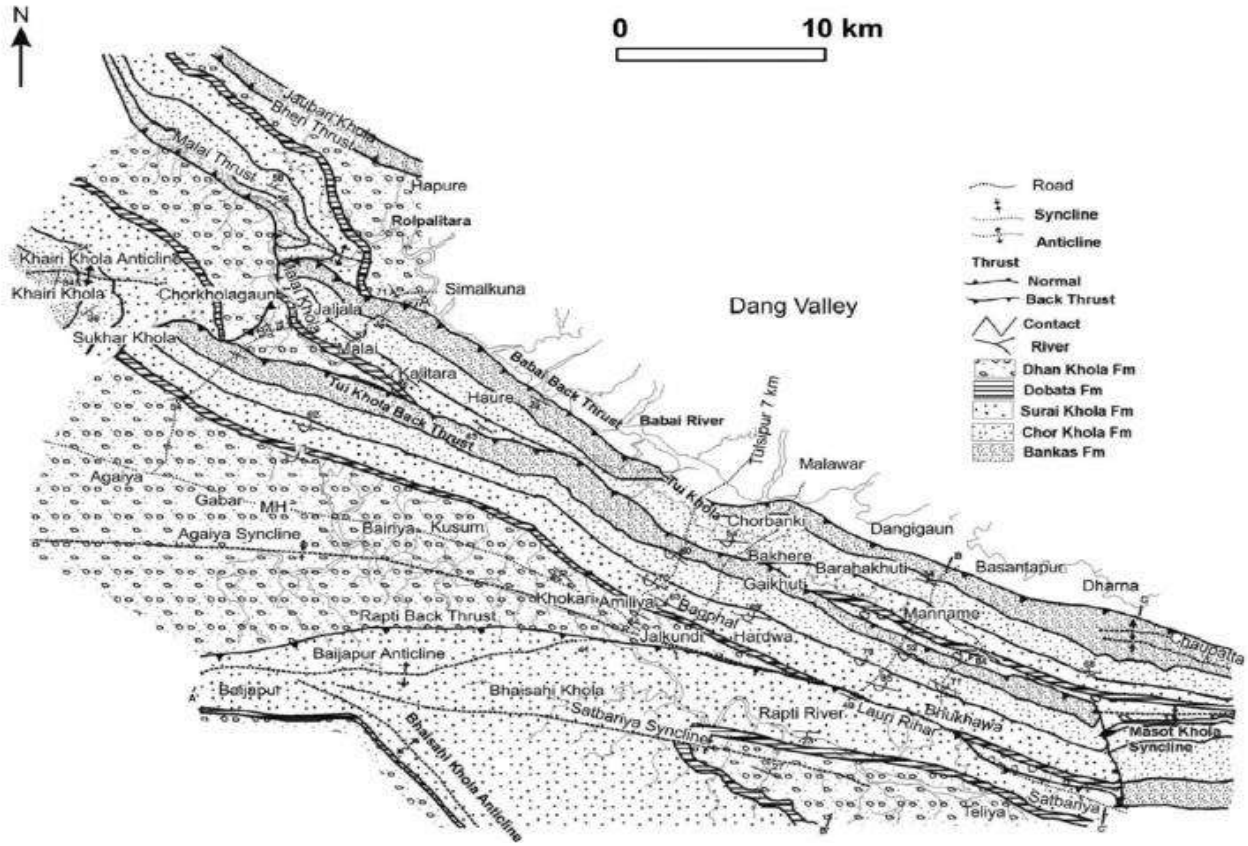

Fig. 2 Geological Map of the area

the thickness of bed. The sandstones are calcareous & rich in plant fossils. The mudstones are variegated in the lower & grey-green in the upper part.

The Surai Khola Formation is mainly represented by multi-storied, coarse to very coarse-grained 'salt & pepper' sandstones. The Dobata Formation is predominated by mudstones with a minor amount of sandstones & conglomerates. The Dhan Khola Formation comprises compact & hard boulders & pebble-bearing conglomerates with yellow mudstones in the lower part & not well-cemented conglomerates with yellow mudstones in the upper part. The Siwalik rocks show a coarsening-upwards sequence, evidencing a continuous uplift of the Himalaya. However, the individual depositional unit shows a fining upward sequence reflecting the fluvial depositional environment. The study area is subjected to more than one phase of the deformational process. Series of faults such as the Bheri Thrust, Mali Khola Thrust, Babai Back Thrust, Tui Khola Back Thrust & Rapti Back Thrust and a number of folds as Baijapur Anticline, Bhaisahi Anticline, Khairi Khola Anticline & Malai Khola Anticline, Agaiya Syncline, Satbariya Syncline & Masot Khola Syncline delineate the study area. The pattern of thrusting here is related to the Thin-Skin Tectonic model.

5.RESULTS & DISCUSSION:

The geological study of Dang valley was first undertaken by Robert M. West from American Museum & the Department of Mines of H.M.G, Nepal in 1976 A.D. The team conducted its study in seventeen localities of Dang. At the time they discovered many fossilized forms of the vertebrate animals from different localities. Similarly, after six years another expedition was also conducted by the same team in the southern figure of the Dang valley. They succeeded to discover the fossil of a horse. This undoubtedly is the first horse fossil that was ever found in Nepal. All these fossils are now preserved at the Swayambhu Natural History Museum. In the Dang valley, many stone tools of palaeolithic & Neolithic have been unearthed from different localities.

The first pre-history study of Dang valley was carried out by Prof. Ram Niwas Pandey of Tribhuvan University in 1966. He found a Neolithic tool at Katuki Sewar, 2 km, south of Narayanpur on the pebble bed of a small stream. It is a long Neolithic axe measuring 19 cm in length, 7.3 cm in cutting edge & 4 cm at the butt. The axe is made of whitish grey phyllite with a green core. Similarly, in 1968 Janak Lal Sharma from Department of Archaeology, H.M.G, found another Neolithic axe from Gwarkhola about a half a mile east of Tarigaun Airport. It was made of Gneissic granite. It is 8.8 cm long & the cutting edge is about 7 cm diameters. Besides these two Neolithic axes, he also found a Neolithic Celt at Bijauri during field work for M.A. dissertation in 1981. It was found at the time of the construction of Ghorahi-Tulsipur road which was dug approximately 10 feet deep from the surface. This is the celt made in dark greenish chalcedony Celica. It length & surface are 7 cm & 5.3 cm respectively. However, the butt is broken.

Fig. 3 Neolithic axe from Bijauri, Dang.

According to Chaudhari (1982), the sandstones of the Lower Siwalik of Nepal are represented by quartz arenites, the Middle Siwalik are characterised by lithic arenites & the Upper Siwaliks are composed by boulders conglomerates with sub-angular to subrounded metamorphic & crystalline rock fragments. The rocks of the Siwaliks in the study area are complicated by many imbricate thrusts, faults &

various types of folds. There are folds ranging in scale from a few centimetres to many kilometres. A very large overturned block of about 50 km in length & 4 km in width occurs in the study area. There are three regional-scale back thrusts which are all trending towards east-west & are nearly parallel to each other. Also, there are two regional-scale forward thrusts, which are dipping towards the north & are trending east-west.

Thin-skinned Tectonics: It is a style of deformation in plate tectonics at a convergent boundary which occurs with shallow thrust faults that only involves cover rocks (typically sedimentary rocks) & not deeper basement rocks.

Structures found in the Study area :

Minor structures: Though the study area consists of many minor structures, the importance once are given below:

Fold: Many small scale folds are observed during the field study. Both open & closed folds are observed.

Fault: The study area comprises many small scale faults. The faults are mostly observed in the 'salt & pepper' sandstones of the Surai Khola Formation.

joints: Joints form in tension in response to tectonic & thermal stress that force the rock to extend.

Slickenside: Those are scratches into the surface of the rock formed as a result of the movement past each other.

***Major structures*:** The main regional structures in the study area are briefly describes below:-

Malai Thrust: The name of the thrust is from the Malai Khola in Dang. It is north-dipping thrust. In the study area, It is observed along the Babai river as well as to the east of the Malai Khola & terminates at the Babai Back Thrust forming a branch line.

Babai Back Thrust: The name is derived from the Babai river, which flows from the southern part of the Dang valley draining out of the whole valley. In the study area, the thrust passes through the entire length of the Babai river along the Dang valley. It is a north-south-west trending back thrust & dips due south.

Tui Khola Back Thrust: The name is derived from Tui Khola river located in the south of the Dang valley. It is also a northeast-southwest trending back thrust, dipping towards the south. The back thrust forms a ramp in the vicinity of the Sukhar Khola in the western extremity of the study area, & then it enters the Malai Khola where is forms a hanging wall flat.

Rapti Back Thrust: The name of the thrust is derived from the Rapti River flowing through central part of Deukhuri Valley. It is also a southeast-northeast trending back thrust dipping towards the south & follows the course of the Rapti River.

Due to this thrusting the rocks, here are repeated more than five times. The Dang Valley is located in a triangle zone bounded by the thrust, which seems to be generated by retardation of faulting, thrusting & folding.

6. CONCLUSION:

The rocks of the study area are highly deformed. The persistence of shortening between Indian & Asia involves their deformation. The deformation is expressed in the form of faults & folds which succeed one another in both space & time. The study area is subjected to more than one phase of deformation process. The study area comprises a series of faults such as the Bheri Thrust, Malai Khola Thrust, Babai Back Thrust, Tui Khola Back Thrust & Rapti Back Thrust. These thrusts show a ramp-flat geometry. The thrusts also have created branch lines and triangle zone. The Dang Valley is situated in the triangle zone formed by the thrusts. Thus it can be said that the formation of the Dun Valley is linked with the pattern of the thrust in that area. There are also a number of folds such the Baijapur Anticline, Bhaisahi Anticline, Khairi Khola

Anticline, Agaiya Syncline, Satbariya Syncline & Masot Khola Syncline

The carving design & Jwalavali depicted on stone slab & other features altogether bring us to the conclusion that the images do not date before the Malla Period. On the contrary, the Sivalingas which was found in Dang Valley, are different from other images. From this, it can also be concluded that the different tradition of Sculpture art influence Dang, in the different time especially early from medieval period

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I am very grateful to Dr Tara Nidhi Bhattarai, who motivates me to write this articles for Geo-World Magazines.
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I was born in Tulsipur sub-metropolis ward no.11, Dang. I attended primary schooling from Shree New Shanti Boarding School, Kataha, Dang and secondary level schooling from Chandrodaya Vidya Kunj, Jaspur, Dang. I have completed my +2 from Gorkha International public H.S. School, Ghorahi, Dang. At first, I had no intense of studying Geology and, to be honest, I was unknown about Geology & it's scope. My first choice of subject was Astronomy & Space Science. But that was not possible subject in Nepal. I had no choice what to do then my big brother advised me to study Geology in Tri-Chandra Campus. Funny right? Wanted to study about Space Science but got stuck in Earth Science.

And, I got admitted in Tri-Chandra campus in GPM combination. Since Geology was a new subject to me, I was so excited to take classes on it. With that joining Tri-Chandra was also exciting things to me. To be honest, I did not struggle with the crowds of here. But got amazed with such a huge mass taking classes in a single classroom. The first thing I was impressed with or unforgettable moment during my first day of Tri-Chandra Campus was the lecture class from Dr Tara Nidhi Bhattarai sir who encountered me with his unique teaching techniques and that diary maintains the system. I think he is the gem of Geology Department of Tri-Chandra Campus. The word "Motivation" is in his voice & "Discipline" is in his action.
The best book I have gone through until this time is "A Brief History Of Time" by great physicist Stephen Hawking which was published on 1988 A.D. by Bantam Dell Publishing Group where he writes in non-technical terms about the structures, origin, development & eventual fate of the universe, which is the object of study of Astronomy & Modern physics. And next book I have gone through until this time is a Novel named "Pagal Basti" by Saru Bhakta which was published on 1991 by Sajha Prakashan. The book describes some of the interesting events & incident, however, even then, the deep philosophy could be sensed & might leave the reader confused as for where to focus in the story or in the philosophy.

The good part of being Geology students in Tri-Chandra Campus is that you get a chance to visit the excursion field of Geology with respected teachers. During the second and third-year field visit "Geology of Nepal Himalaya" was the best subject that got my enthusiastic to study. But in the fourth-year field visit, there was next subject, Engineering Geology, which diverted me towards it. This subject helps us to apply our geological knowledge & geotechnical recommendations analysis & design associated with human development & various types of structures. During the fourth year time, I made some friends & some helpful friends.

Besides studying, I love playing music: composing & singing and sports like cricket & football. If things go well one day, I will be a good Geologist.

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GEOLOGY OF MOUNT EVEREST

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Abstract:

The highest, youngest and a very highly active mountain range is the Himalaya and it is a type locality for the study of the ongoing continent-continent collision. Mt Everest which is the highest mountain of the earth lies in the Himalayan range and is also known as Sagarmatha in Nepal and Chomolungma in China. Its peak is 8,848 meters above sea level. Rocks comprising Mt Everest have been divided into three units called formations and each formation is separated from the other by low angle faults which are called detachments. The geology of Mt Everest is simple, which is a huge slice of solidified sediments that once lay at the bottom of Tethys Sea, an open waterway that existed between the Indian Subcontinent and Asia over 400 million years ago. This article tries to describe the geology of the highest peak of the earth.

Keywords: Himalaya, Mt Everest, formations, detachments, Tethys Sea

1. BACKGROUND

Mt Everest, which is one of the largest and most distinct geographic features on the earth's surface lies on the Himalayan range. This Himalayan range is 2300 kilometres (1400 miles) long and width varies between 140 and 200 miles and crosses five countries Nepal, India, Bhutan, Pakistan and People's Republic of China. Geologically speaking the Himalayas and Mount Everest are young which began forming over 65 million years ago when the two of the earth's greatest crustal plates, the Eurasian plate and the Indo Australian plate collided. The Indian subcontinent began to move north eastward after separating from Gondwana land mass and crashes into Asia. The crashing of the Indian subcontinent with Asia results in folding and faulting of the plate boundaries which cause Himalaya to rise. The Indian plate is gradually pushed under the Eurasian plate about 1.7 inches per year, which creates pressure forcing the Himalayas and the Tibetan Plateau to rise from 5 to 10 millimetres per year. Due to the higher density of heavier rocks, they are pushed back down into the earth's mantle at the point of contact. The lighter rocks like limestone and sandstone are pushed upward. The 400 million-year-old fossils of sea creatures and shells that were deposited at the bottom of shallow tropical seas are exposed at the top of highest peaks, like Mount Everest. The sedimentary rocks found on the Mount Everest are limestone, marble, shale and pelite that are divided into rock formations. Below the sedimentary rock layers, there are older rocks including granite, pegmatite intrusions, and gneiss, a metamorphic rock.

Figure 1: A view of Mount Everest (Source: ThoughtCo.com)

2. OBJECTIVES

The main objective of this article is to give information regarding the geology of the Mt Everest including the rock type found on the summit and below of the summit of the Mt Everest and to mention about the mountain building processes.

3. METHODOLOGY

Available secondary sources such as documents, articles, books, published news, journals and various data from the internet and the web. Among the sources, the web is widely used to collect the information. The collected information is organized in a systematic way to present this article.

4. FIELD INVESTIGATION AND DATA COLLECTION

4.1 GEOLOGY OF MOUNT EVEREST

Mount Everest is composed of three distinct rock formations. From the summit to its base the rock units are the Qomolangma Formation, the North Col Formation, and the Rongbuk Formation. Each of these formations is described below.

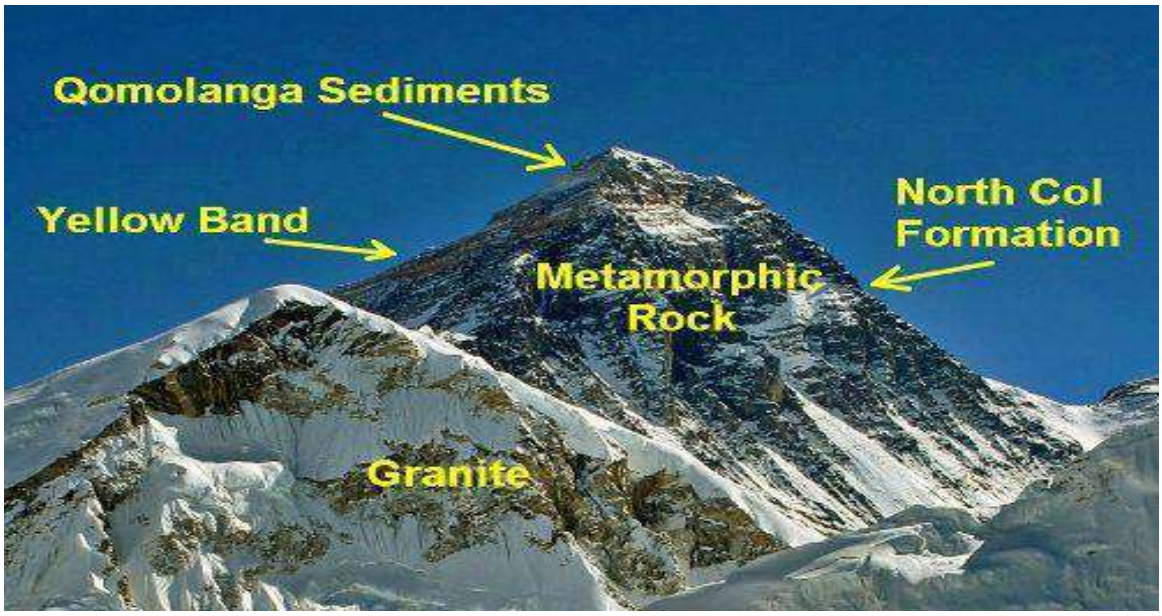

Figure 2: Geology of Mount Everest with three distinct formations (Source: ThoughtCo.com)

4.1.1 THE QOMOLANGMA FORMATION

It is the highest rock on the summit pyramid of Mount Everest that runs from the summit to the top of the yellow band, about 8,600 meters above sea level. It consists of greyish to dark grey, parallel laminated Ordovician age limestone. The upper layer of this formation consists of fossil including trilobites, crinoids, and ostracods. This formation is broken up by several high angle faults that terminate at the low-angle normal fault, the Qomolangma Detachment. This detachment separates it from the yellow band.

4.1.2 THE NORTH COL FORMATION

It extends from the base of the Qomolangma Formation to the 7,000 metres high above sea level. It is divided into several distinct sections. The upper 400-metre section of this formation consists of intercalated beds of Middle Cambrian diopside-epidote bearing marble with its distinctive yellow colour. It also consists of phyllite with muscovite and biotite, and semi-schist, a slightly metamorphosed sedimentary rock. This yellow band also contains fossils of marine organisms. Various schists formed by metamorphism of limestone, sandstone and mudstone are found in lower 600 meters. The base of this formation is a regional low angle normal fault called the "Lhotse Detachment", it divides the North Col Formation from the underlying Rongbuk Formation.

4.1.3 THE RONGBUK FORMATION

It forms the base of Mount Everest consisting of sillimanite k- feldspar grade schist and gneiss by numerous sills and dykes of leucogranite.

5. CONCLUSION

Mount Everest consists of sedimentary and metamorphic rocks that have been faulted southward over the continental crust of the Indian plate during the Cenozoic collision of India with Asia. The marine sediments of Qomolangma and North Col Formations were accumulated within the continental shelf of the northern, passive continental margin of India prior to its collision with

Asia. The high-grade metamorphic rocks of Rongbuk Formation were the result of the alteration of high-grade metasedimentary rocks. The Himalaya is rising about 5 mm per year. The movement of the surface of the earth pushes upward the sea floor to the sufficient height resulting the summit of Mount Everest to be marine limestone.

ACKNOWLEDGEMENT

I am very grateful to Dr T.N. Bhattarai for giving me this chance to express my learning skills through this article. I am very thankful to Editor Ankit Dhakal for giving instructions about writing this article and his support for editing.

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About the Author of *Geology of Mount Everest*

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I was born in Mahankal, Kathmandu Metropolitan city ward no. 6, Boudha Kathmandu. I studied primary level education at Kathmandu Vidhya Mandir Mahankal, Panitanki and completed plus two from Reliance International Academy Chabhahil, Kathmandu. Knowing information about geology from a relative, I admitted in Bachelor level for Bsc at Trichandra Multiple Campus. When I first visited Trichandra Campus, Ranipokhari attracted me a lot because it was something I have read in a history book but have never seen before.

The best book I have gone through until that time was Mind Power by Dr Yogi Bikashananda. The book conveys the message about the power of Subconscious mind. Similarly, the best book I have gone through, published by foreign authors is You Can Win. It holds the message that success is the result of habits and habits is the result of action which all starts from a right thinking.

The best thing that I have learned during my school life is that the most important asset a student has is his/ her discipline.

Being heard that the environment and education system is not good in public colleges, I was quite unhappy during my earlier days. But, Department of geology was so separate and so different from the rest. While coming at the end of the third year course, I started liking Geophysics the most. It tells about the underground geology and its different properties with the help of artificially induced Electrical, Magnetic or seismic sources. It encouraged me to select Geology as a major subject in my 4^{th}-year study.

Studying geology in 4^{th} year was even more interesting because of long field work and many other academic activities organized by the Department. During the field work, Geological mapping attracted me a lot because it was the best tool to know how rock typed and geological structures are changing horizontally and vertically in the area.

Considering the facts mentioned above and also based on my own wisdom, I would expect to be engineering geologist in 10 years from now.

GEOLOGICAL STUDY OF THE BUTWAL-TANSEN AREA, WEST CENTRAL NEPAL

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1. INTRODUCTION

Geology is essentially an applied science. It deals with the study of interval activities of the earth as well as geomorphic features of the earth crust. Our Tansen field is conducted according to Tribhuvan University of the fourth-year syllabus. It was carried out in Butwal-Tansen Palpa-Malunga area for 28 days from 15th Mangsir to 12th Poush 2073.

The field work was carried out in four phase i.e. General Geology, Engineering Geology, Hydrogeology, Exploration and Mining Geology. The general geology includes stratigraphy and geological structure of the study area. Engineering geology comprises engineering properties of soil and rock mass, slope stability analysis and mass movement. Drilling method of deep tube well, shallow tube well, estimation, and calculation of groundwater consist on Hydrogeology. Exploration and mining geology includes reserve calculation of construction material and much more.

2. LOCATION

Our excursion area lies on Western Nepal, between the geological boundary Gandaki River in east and Bheri River in the west. The geographic location of our study area is situated in Nawalparasi, Rupendehi and Palpa district of Lumbini zone and Syangja district of Gandaki zone. It is about 285km west of Kathmandu. The study area extends from latitude 27°40'30"N to 27°52'53"S and longitude 83°24'33"E to 83°35'04"E. Geologically our study mainly consists of Indo- Gangetic plain, Siwalik and Lesser Himalaya region.

Figure 1 Location Map of Study Area

3. ACCESSIBILITY

Tansen is 25 miles (40 kilometres) from Butwal and 78 miles (125 kilometres) from Pokhara. By bus, it takes 1 hour from Butwal and 5 to 6 hours from Pokhara. Regular public buses are available from Butwal, Pokhara and Kathmandu. The total road distance from Kathmandu to Tansen is about 187 miles (about 300 kilometres), and a journey of 11 hours.

4. TOPOGRAPHY AND DRAINAGE

The topography of our study area wasn't easy. Different steep slope and the gentle slope was present with the fragile rock type. The slopes here are from very steep to gentle. The steep slope is being found to be of 30 degree and gentle slope of 70 degrees. The area, as a whole, exhibits high drainage density. All the streams are in youth stage. Because of the high gradient, water flows with high current. High flooding on the stream occurs during the rainy season from middle June to middle September.

5. LAND USE

This area represents a high development of the usable land. Most of the areas are covered by the gentle slope with fragile rock mass. Major crops of the area are sugarcane, maize, millet, wheat, rice etc. Many fruits such as litchi, banana, papaya etc are found. Different kind of land system is being found along the study area. Basically, alluvium soil and fertile soil is found in this region which is suitable for cultivation.

6. OBJECTIVES

To gain the exact knowledge of our study, the study within the class is insufficient for any subject. Therefore field study is must for any subject.

The main objectives of our field visit are as follows.

- To learn about the rock type.
- To study about the different geological features.
- To study about the natural hazards.
- To study about the possible way to control the natural hazards.
- To be clear enough about joint, bedding plane and hillslope.
- To study about the rock mass discontinuity.

7. METHODOLOGY

Many methods and techniques were applied in our geological excursion. Beside book study the lecture of Engineering, Mining and Exploration and Hydrogeology were taken. Initially, topo map 099-09, 099-05 and 098-12 is managed. The instrument like Brunton compass, acid, hammer, etc. are the tools that are used in our excursion and also using the map of 1:25000 scale. We studied the geology of the area, observed the different Formation their boundary and the depositional environment by using above discussed tools. Finally, we prepared the geological map, Route map, cross section and columnar section of our study area, using graph paper and compass traverse along the study area.

8. FIELD INVESTIGATION

8.1 Terai Plain

Terai zone is the northern continuation of the Gangetic plains of India. It extends from the Indo – Nepal border in the south to the base of Churia or Siwalik hill in the north. Geologically this zone is composed of recent alluvium deposit consisting of sediments in the north and finer sediments like silt, in the southern part.

8.2 Siwalik

This group represents the lower hill of the Churia range which lies between MFT (south) and MBT (north). The Siwalik constitutes the narrow belt of 20km to 30km in width 5km to 6km in thickness runs east-west. The age range is indicated as Middle Miocene to Early Pleistocene. This zone is covered by dense forest and the fossiliferous horizons are frequently occurring in this zone. Geologically this zone composed of loose to consolidate north dipping sedimentary rock like conglomerate and stone, siltstone, mudstone and marl.

8.3 Lesser Himalaya

This zone lies to the north from the Siwalik. Lesser Himalaya zone of Nepal forms the major geological zone and is important in the majority of the hill population of the view. The metamorphosed young sedimentary rock of Churia or Siwalik zone is directly in contact with metamorphosed rock sequence of lesser Himalaya which is separated from the Siwalik by the MBT. Geologically this zone mainly composed of low-grade metamorphic intrusion like granite, syenite, pegmatite etc in this zone. On the basis of the rock types and textures, the correlation of the rocks of the Lesser Himalaya (Sakai 1985) of the West-Central Nepal and the Central Nepal is given in the correlation chart below.

Table 1: Correlation Chart of the rocks from West- Central Nepal and Central Nepal

Tansen- Palpa Area	Central Nepal
Kerabari Formation	Robang Formation
Malekhu Formation	
Ramdighat Formation	Benighat Formation
SaidiKhola Formation	Dhading Dolomite
Khoraidi Formation	
Chappani Formation	
Virkot Formation	Nourpul Formation
Heklang Formation	DadagaonPhyllite
Naudada Formation	Fagfog Quartzite
Andhi Formation	Kuncha Formation

9. DISCUSSION AND CONCLUSION

The study area (Butwal-Tansen) is a part of the Indo-Gangetic Plain, Siwalik and Lesser Himalaya Which lies in west-central Nepal. In Indogangetic plain, it consists of fluvial deposit like, sand, silt pebble, cobble which comes from Siwalik. This zone is also called bhabar zone which is rechargeable. From the northern part of Indogangetic plain Churia or Siwalik is started. The lithological composition of Siwalik is fine- to coarse-grained, variegated, bioturbated, mudstone, sandstone and conglomerate. The Siwalik group is further sub-divided into lower Siwalik, Middle Siwalik and Upper Siwalik. The Churia zone is bounded to the north by the Main Boundary Thrust (MBT) and to the south by the Main Frontal Thrust (MFT). The rock of Churia zone is fragile in nature so erosion rate is high. Geologically Lesser Himalaya consists of two sequences of rocks: Kaligandaki Super Group and Tansen Group. The Kaligandaki Super Group has been sub-divided into the Adhi Formation, Naudada Formation, Heklang Formation, Virkot Formation, Chappani Formation, Khoraidi Formation, Saidi Khola Formation, Ramdighat Formation and Kerabari Formation. Similarly, Tansen group is sub-divided into, Sisne Formation, Taltung Formation, Amile formation, Bhainskati Formation and Dumri Formation.

ACKNOWLEDGEMENT

I would like to express my humble and special thanks to Department of Geology, Tri-Chandra Multiple College for providing the concept of formation of rock, which has broaden our mind and make us familiar with actual field knowledge. I would like to express my cardinal thanks to HOD of Geology Department Mr Madan Ratna Manandhar sir and other teaching staff who helps me directly or indirectly.

Lastly but not least I am eternally grateful to Dr Tara Nidhi Bhattarai sir who gave the opportunity to write this article.

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About the Author of *Geological Study of the Butwal-Tansen Area West Central Nepal*

Year of Admission: 2070
Name: Saugat Khadka
Roll No: 647
Subject Combination: Geology, Physics, Mathematics

I was born in Ghamtara-2, Dolakha. I attended my primary class at Gothatar English Secondary School, Gothatar and completed by school level study from there. For higher level study I join the Xavier International College, Kalopul, Kathmandu and complete intermediate from there. Initially, I was not interested in joining B.Sc. in Tri-Chandra Multiple College. I want to study engineering but one of my cousins gives me information about geology in Tri-Chandra Multiple college and its scope. He suggested me that geology also a technical subject you can join B.Sc. in Tri-Chandra Campus and study geology as a major subject. So I did according to him. I joined B.Sc. in Tri-Chandra Multiple College in Geology, Physics, and Mathematics combination for bachelor's level study.

I have read some books and novels and book which inspired me much more is "You can win" by Shiva Kheda.This book which generates energy inside me and gives the courage to do something new. Some of the novels that I have read are: "Basai" by Lil Bahadur Chhetri, "Ek Chihan" by Hirdaya Chandra Singh Pradhan. Novels which is written by foreign writers are "The Old Man and the Sea" by Ernest Hemingway, "Brida" and "Veronika Decided to Die" both by Paulo Coelho and "Revolution 2020" by Chetan Bhagat.

At first, I was so embarrassed at tri-Chandra Campus huge classroom, dirty class, amazing benching system which I have never seen. Another interesting thing was that classroom was changed period by period, sometimes there used to be a huge gap between two periods and sometimes we don't even know the which period is going on because teacher directly enters into the class and without introduction, they started their lesson which is really bored.
By the time I made friends who helped me and I helped them too. Our problem was same and finally, we make our way at Tri-Chandra Campus memorable.

The first class of "Geology" which I attend in Department of Geology Tri- Chandra Campus, Ghantaghar was still fresh in my mind. From that day I was really interested in Geology. It is the really fascinating subject. The topographic profile which we draw in the graph papers gives the information about geological features like peak, spur, saddle, slope which is really interesting.

Now, I am studying Geology in 4th year and in near future, I am going to complete my bachelor's level study. And want to be a good geologist.

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CHANGE IN PERCENTAGE OF OXYGEN IN BAGMATI RIVER ACCORDING TO SEASONAL VARIATION

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Abstract:
The Bagmati River is the holy to the inhabitant of the Kathmandu Valley. Due to population growth and rapid urbanization, the river is under increasing pressure. The water quality of Bagmati river in the valley is chemically and biologically so degraded that it cannot be used for any purpose and no any aquatic animal can survive from Teku to Balkhu during winter season due to lack of oxygen.
Key Words: *Bagmati River, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Water pollution, Urbanization*

1. INTRODUCTION

Bagmati River is one of the holiest rivers for Hindus. Hindus use to worship a god and they are cremated on the bank of river. The source of the Bagmati River is Bagdwar, Shivapuri Hill (2,660 m). It flows south and merges with the Ganga. This river is also boundary between Kathmandu and Lalitpur. The tributaries of the Bagmati River are the Bishnumati, the Hanumante Khola, the Manohar Khola, the Dhobikhola, etc. Many settlement and religious Temple are located around this river which is leading toward increase in pollution level. Sewage, industrial discharge, waste generated by a religious activity, waste dumped by people are major cause of pollution which is directly decreasing oxygen level.

2. OBJECTIVES

The main objectives of study are enlisted below:
i) To determine Dissolve Oxygen (DO) and Biological Oxygen Demand (BOD)
ii) To know the relationship between Dissolve Oxygen and precipitation.

3. MATERIAL AND METHODS

3.1 Sampling site:
According to feasibility and change in quality of water, sampling sites were chosen from Sundarujal-Chovar, which are listed in Table 1.

Table 1 Sampling Sites

Site no.		Site no.	
S_1	Sundarijal	S_6	Teku
S_2	Jorpati	S_7	Kalimati
S_3	Tilganga	S_8	Balkhu
S_4	Sankhamul	S_9	Sundarighat
S_5	Thapathali	S_{10}	Chovar

Fig 1: Sampling spots

3.2 Sampling:

Sampling was carried out during summer (May-June), monsoon (July) and winter (Jan- Feb) in 2016. For the purpose of Dissolve Oxygen (DO) 250ml of water was sampled and 500ml of water was sampled for the purpose of Biological Oxygen Demand (BOD).

3.3 DO and BOD analysis:

Dissolve Oxygen (DO) was measured in situ and BOD was measured by keeping sampled bottle with tight cap in dark room and again, DO was measured after five days.

$$BOD = DO_{initial} - DO_{final}$$

Fig: Dissolved oxygen analysis

4. RESULT AND DISCUSSION

Table 2 shows that % of O_2 level is lower during winter season and summer season and increases during monsoon season. Again DO decreases after monsoon.

In summer and winter seasons, DO level reaches up to anoxic level where no any aquatic animals can survive in several site.

Table 2 Calculation of DO and BOD

Site no.	May-June (Summer)		July (Monsoon)		Jan-Feb (winter)	
	DO Average	BOD Average	DO Average	BOD Average	DO Average	BOD Average
S_1	6.9	6.2	7.9	7.6	6.7	6.2
S_2	6.6	6.4	7.2	6.9	6.4	6.2
S_3	5.2	5	6.4	5.9	6	5.4
S_4	5.4	5	5.8	5	4.4	4.1
S_5	2.56	2.4	3.9	3	3.2	3
S_6	2.4	2	3.9	3.2	2.3	2
S_7	3.1	2.8	4	2.4	1.9	1.2
S_8	3.8	3.4	4.4	4.2	2.6	2.2
S_9	4.6	4.2	4.9	4	2.9	2.3
S_{10}	4.4	4	5.4	3.9	2.3	2

As the precipitation increases DO also increases because rain water have some amount of oxygen which when mix with normal flow of water will lead to increase in DO level.

During our work we found that before monsoon at S_{10} oxygen level up to 1.2 mg/l in which fish can't survive but after at monsoon time people were fishing around area.

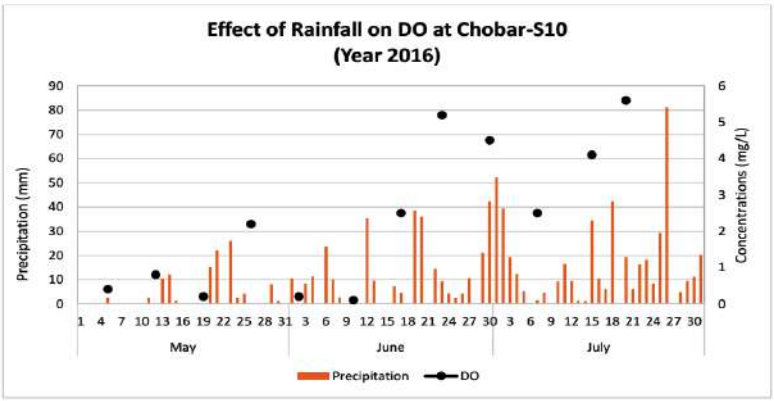

Fig 2: Effect of rainfall on DO at Chovar.

5. CONCLUSION AND SUGGESTION

Change in DO according to season is due to precipitation (ppt). As ppt increases DO also increases, however no any fish can survive from Teku to Chovar due to low DO.

So, to maintain the river, along with control in population, sewage industrial discharge, waste generated by religion activity, waste dumped by people should be controlled.

ACKNOWLEGEMENT

I would like to thank UNI environment science department for conducting this project. I also acknowledge the Project Director Prof. Dr. Mohommad Iqbal, Co-ordinator Dr. Tara Nidhi Bhattarai and Mr. Sushil Tuladhar for their support in each and every step of our project.

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About the Author of *Change In Percentage Of Oxygen In Bagmati River According to Seasonal Variation*

Year of admission: 2070
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I was born in Kirtipur-6, Kathmandu. I did my schooling from Shubhakamana Academy, like wise I completed my intermediate from, Kathmandu Bernhardt College, Kathmandu. Initially I wanted to be an engineer and I was not thinking to join Tri-Chandra Multiple Campus. According to my wish I got chance for engineering from Kathmandu University (KU) by getting 30^{th} position in entrance exam but I didn't take admission at K.U. I also got chance for engineering at Thapathali Engineering Campus but I gave up engineering and joined Tri-Chandra Multiple Campus by knowing about geology from geologist Murari Acharya. I am totally satisfied with geology, I am incomplete without geology and geology is everything for me.

I like writing books. I have already published couples of books naming Pocket Mathematics and Pocket Science from Shiva Publication for 10 + 2 entrance exam. Although I am student of geology I have great interest in Mathematics.

Department of geology is totally different from other department; it always think about student and provide different opportunities for students for their career development. Our department gave me a great opportunity to join in research programme with University of Nothern Iowa from U.S.A. to check quality of water from Bagmati River.

I have gone through different parameter during our research but I have written an article only on a single parameter of my interest.

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RANIPOKHARI: PRESENT CONDITION AND IMPORTANCE

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Abstract

Ranipokhari, an infiltration pond, lies at the center of Kathmandu and covers an area of 2.5 hectare. The infiltration pond captures and temporarily stores rain water before allowing it to infiltrate into the soil. Such infiltration ponds are the source of water in the stone spouts. The water of Ranipokhari is drying up since long; increased temperature, increased number of tubewells and increased settlement are the reasons behind it. Due to the poor management and ignorance of Kathmandu Metropolitan City, the pond is facing a lot of problems these days. The conservation of such historical and cultural heritage site is important. If we save Ranipokhari; one hundred year later, our grandchildren will visit the same place and they will be proud on us. So sooner than later some strict action should be taken and strict rules and regulations should be implemented to manage groundwater.

1. Introduction

Ranipokhari is a historical artificial pond which lies at the heart of the capital city, Kathmandu. It was built in 1670 A.D. by King Pratap Malla. The pond is one of Kathmandu's most famous landmarks, and is known for its religious and aesthetic significance. Its dimensions are 180 m × 140 m. The pond was built by the king to console his bereaved queen. He had water collected from various holy places and river confluences in Nepal and India. There is a temple of Lord Shiva at the center of the pond. In the eastern side, there is Ghantaghar which lies in the premises of Tri-Chandra Multiple Campus. The pond is one of the most important tourist attractions.

Ranipokhari is an infiltration pond. According to Wikipedia, "An infiltration basin (also known as a recharge basin or in some areas, a sump) is a type of best management practice (BMP) that is used to manage stromwater runoff, prevent flooding and downstream erosion, and improve water quality in an adjacent river, stream, lake or bay". Mostly infiltration ponds are artificial and are designed to infiltrate the storm water through a permeable layer into the groundwater aquifer. To construct an effective infiltration pond, there should be a small gap between the base of the pond and the water table.

2. Objectives

The main objective of this research is to study the present condition of the historical pond- Ranipokhari and to make people aware about the importance of the infiltration ponds of Kathmandu.

3. Methodology

This article is only for the academic purpose. At first desk study was carried out which included the study of some books. It would be worthwhile to admit that due to the limited research and time, the site investigation was not done properly. Data are collected from the internet sources, some old reports and some materials are obtained from Department of Hydrology and Meteorology. Interviews with some key informants were also carried out to delve

into the more details on the issues of research.

4. Data Collection and Analysis

The water of Ranipokhari has been getting dry since 2004 A.D. (Hari Shankar K.C., Ratnapark). The main source of water in the pond is rainfall. Due to this reason the level of water in the pond rises up during monsoon season and gets down in the dry season. The aquatic life is also affected by the seasonal fluctuation of the water in the pond. The pond is also being filled by the water pumped from the tube well at Khullamanch.

Ranipokhari, Panipokhari, Naagpokhari are some of the infiltration ponds in Kathmandu valley. The main purpose of these ponds is to recharge the groundwater. Rain water collected in the pond gets infiltrated through the layer of top soil and hence the groundwater is recharged.

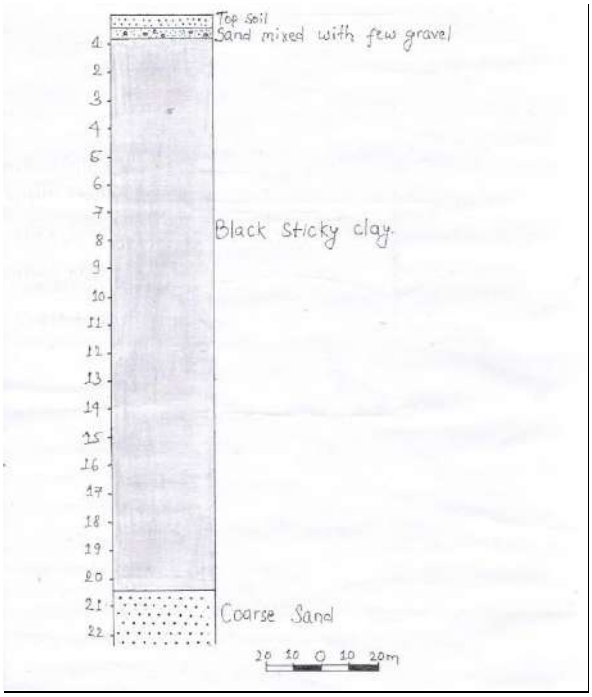
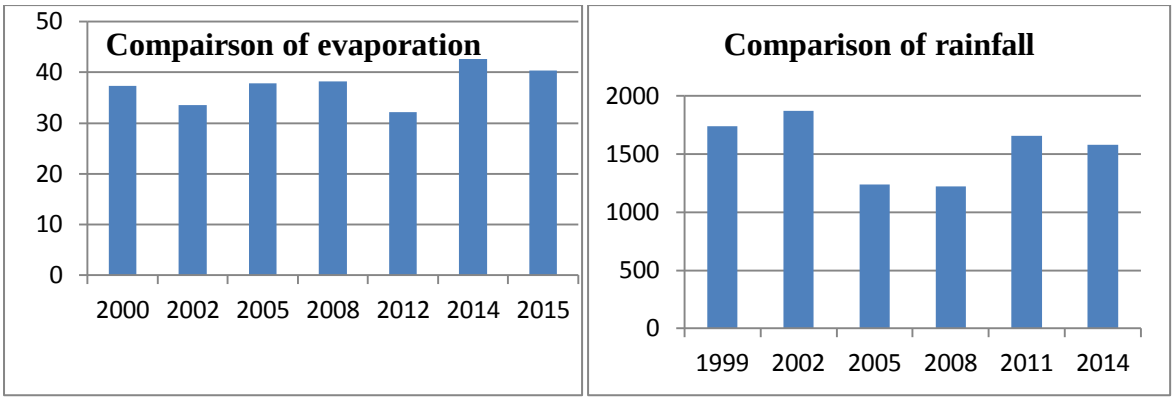


Fig 1: Litholog of Ranipokhari area

(Source: Groundwater Resources Development Board, Babar Mahal)

The water in these ponds is the source of stone spouts and is used as drinking water. The water of Ranipokhari used to flow through the underground channel and used to get discharged through the ancient stone spouts of Bhotahiti and Jamal. It is estimated that 1 billion liters of water can be used from a stone spout in a year. During those times the water current at the taps of Sundhara used to be so forceful that one had to be scared of losing balance and falling hard upon the stone platform. At the present, Ranipokhari is used only as a site for tourism.

The rate of infiltration depends upon the amount of rainfall and evaporation. One of the reasons for the decrease in the level of water in Ranipokhari is the increase in evaporation. The comparison of rainfall (1999-2014) and evaporation (2000-2015) are presented below.



(Source: Department of Hydrology and Meteorology, Naagpokhari)

From the above chart, it is clear that the amount of annual rainfall in 2014 is nearly equal to the annual rainfall of 1999. On the other hand, the annual evaporation has increased which has led to the decrease in the infiltration rate.

Increase in settlement is the other reason for the decrease in the level of water in Ranipokhari. Due to the increased settlement, the recharge area has decreased. Due to this, the infiltration of rain water is minimized. Examples can be taken from the infiltration ponds of Lalitpur district where these ponds do not get dry throughout the year. The reason behind this is that the recharge zone is large. It is found that in Kathmandu Metropolitan City (KMC), the area used for settlement in 1989 was 2454 hectares and in 2006, it was 5732 hectares (https://www.slideshare.net/tryambakesh/kathmandu-settlement-geography). This shows that in 17 years, the recharge area has decreased by more than half. Currently there are many deep tube wells in KMC which are constructed for pumping drinking water from the deep ground. Many deep tube wells are used for business purpose and large amount of water is pumped through these tube wells. This has caused the drawdown of groundwater. An example is shown in the figure 2.

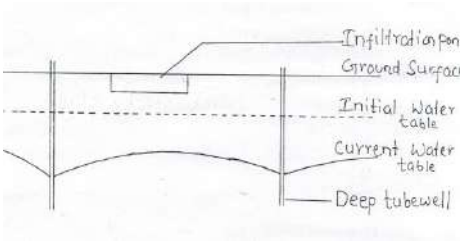


Fig 2: Figure showing drawdown due to the excessive use of deep tubewells.

After the earthquake of 25th April 2015, the condition of Ranipokhari has become worse. Balgopaleshwor Temple at the center of the pond is damaged by the massive earthquake. Right now, the pond has been dried up and reconstruction is being done. Besides other intricate structures like Kastamandap, Maju Dega or the Char Narayan Temple, the government has picked Ranipokhari to launch the national reconstruction campaign, with much fanfare.

5. Conclusion

Ranipokhari is one of the important heritages of Nepal. Besides hydrogeological importance, it has historical, cultural and religious importance. Due to the poor management and ignorance of KMC, the pond is in worse condition. It is also a responsibility of each individual to conserve such sites. With the increasing population, the use of groundwater is also increasing day by day. The unplanned settlement and the increasing number of buildings and other infrastructures have decreased the amount of infiltration of water. To improve the condition of Ranipokhari and to stop the water from being dry, large amount of water should be kept in the pond within a certain interval of time until the surface becomes oversaturated. Certain act should be implemented in the city to control the unplanned use of groundwater. The tube wells which are used for industrial purpose should not be built inside the city. KMC should also be concerned about the water pollution. People should be made aware about the importance of Ranipokhari and other ponds and about the impacts of the water pollution.

ACKNOWLEGEMENT

I am highly indebted to my teacher Mr. Nir Shakya for his guidance and constant supervision as well as for providing necessary information regarding the research and also for his support in completing the research. I would also like to express my gratitude to Dr. Tara Nidhi Bhattarai for giving me such an opportunity to publish my article in the bulletin "Geoworld, vol. 8, 2017".

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Department of Hydrology and Meteorology

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About the Author of *Ranipokhari: Present Condition and Importance*

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I was born in Jhorahat VDC, Morang. I completed my school from Azalea Secondary Boarding School, Biratnagar. I passed my +2 from Arniko Higher Secondary School, Biratnagar. At first I was totally unknown about the subject geology. My uncle suggested me to get enrolled in this subject. I visited Tri-Chandra Multiple Campus and gathered some information about geology from seniors. I liked the subject and I made a proper plan to make my career in this field. Tri-Chandra Multiple Campus is the first campus of Nepal and Ghantaghar which is the historical heritage was the part of this campus. So this thing also attracted me to study here.

Helping others is one of the great things that everyone can do. Besides my study, my career and my profession; the other thing I like to do is social work. Till this date, I have participated in blood donation programs organized by "Youth for Blood" and "Clean City-Biratnagar" organized by Lions Club, Biratnagar. I also like to volunteer in the cultural and social programs.

"Khalanga ma Hamala" by Radha Poudel is the best book that I have gone through. This book explains about the poverty that everyone talks about Karnali zone. The book is largely about the night of the attack but also on the injustice that poverty wrings, the inequality between the Capital and Karnali, and the vast difference between policymakers and people in Jumla.

During my early days in Tri-Chandra Multiple Campus, I was much more excited to make new friends and to study form new teachers. The education system in this college was entirely different for me. The classrooms were large the mass of students was enormous.

In the four years of my study, the most interesting topics for me were "Structural Geology" and "Engineering Geology". Learning about the geological structures, their shape and three-dimensional distribution of the rocks with respect to their deformational history were much more exciting things. Engineering Geology also known as people's geology is the subject in which I learned to help people from natural hazards by managing the risks.

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DIFFERENCE IN THE DRINKING WATER SYSTEM ALONG THE KALI GANDAKI VALLEY

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Abstract
The study was done from Jomsom, Mustang to Tatopani, Myagdi. The research focuses on the source of the drinking water, the purification system and the quality. The secondary focus was on the problems with the supply of the water from the source. The study area was divided into three sections; Jomsom to Tukuche, Tukuche to Choyo, Choyo to Tatopani. Every village has their water from the spring. Most of the villagers drink water directly and are satisfied with the quality. Higher altitude region has icing problem, mid altitude region has calcite and icing problem and lower altitude region has debris problem.

Key terms: *Spring, Geomorphology, Survey, Kali Gandaki Valley*

1. BACKGROUND

Being a Himalayan country, we have sources of spring all over the country. Since Northern Mustang lies in the rain shadow zone, it receives very less water fall and has very few springs within it. But the same district receives monsoon rain in southern part with a large number of springs. The springs are abundant only during monsoon. It's always hard finding a better source to sustain for a whole year. The people of Mustangs have now been funded by British Gurkhas allowing them to have water from the far away source and sustaining for the whole year.

2. OBJECTIVES

The objectives of the survey are:

- To know the source of the drinking water i.e. spring, river, well etc.
- To know how villagers purify their water
- To know if the villagers are satisfied with the water they are getting
- To know the problems related to the drinking water system

3. METHODOLOGIES

The study was carried on by asking the villagers along the Kali Gandaki valley from Jomsom to Tatopani. Every question was asked on basis of the ethics. None of the interviewees was a minor and none of them was forced to answer the questions. The answers were noted on the notebook and if a possible visit to the spring source was done with help of the local people and police officers.

4. RESULTS

Jomsom being the most crowded town of the region, most of the people didn't know

where their water comes from. The army camp uses the different spring water source than of the town people. Since it headquarters of Mustang, it has a regular supply of water throughout the year. Just on the outskirts of the Jomsom, the story is different. This part of the village has huge water supply cut throughout the year. The only supply is in the morning (4 a.m. to 9 a.m and few hours in evening). They drink the water with any purification techniques but are satisfied with its quality.

Syang village used to have a single source of water two years back. But due to drying out of water during the dry season like in April, they build another tank in the other source. They still need to cut the water supply during night time for the collection in the tank during the dry season. The major problem this Syang village and outskirt of Jomsom is the icing inside the pipe in the winter season (December and January the most). Usually, they heat the pipe to melt the ice and have a regular supply. The water supply is 24 hours in Syang village after they started to use the second source except for the extreme dry season.

Marpha has the twice as good supply of water from single spring source than of the Syang village. They also use some treatment techniques like filtration and boiling. Still, most drink the water directly. This village also has the icing problem like of Syang and they use the boiled water to melt the frozen water inside the pipe.

Chairogaun has to use the alternate source for the dry season. They use the Chairo spring source during the wet or rainy season and during the dry season, they have to shift to lucky Khola for the supply. Surprisingly, most of the people in this village use the boiling procedure for the purification.

Chimangaun uses the single spring source from where Jhminu Khola starts and have a regular supply throughout the year. The supply is low during the dry season but enough to sustain.

Tukuche is the village where all drinking water related problems of the Kaligandaki valley meet at one place. They also have the single spring source coming out of Batasedada. They experience problems due to freezing during the winter season. They cut the pipes to deal with this problem. The other problem is the debris content in the supplied water during rainy season. They use the cotton clothes to trap the debris but no use of any purification technique.

Koban is the most interesting village of all. Almost every house owns a single spring source. The whole land is so saturated that everywhere there is spring. One house has the underground spring discharge so they made a tap before building the house. Even though it snows during winter but there is no problem of icing. The purification techniques vary among houses; some filters,

some boils and some just drink directly depending upon the debris content in their water.

Kokhethanti village experience the problem of calcite content in their supply. The other problem is a large amount of debris content in the supply. During the rainy season, they also encounter the frogs and small snakes in their water. They use the sedimentation technique to separate the debris before consumption. The calcite problem is at extreme in **Kunjo and Titi** village. They have a cm thick calcite precipitation in a boiling pot in a week. They use the cotton cloth to filter the calcite (Photo 1) at first and then boil to drink. The same problem is at **Chhyo** village as well. As we move south, the debris content increases during the wet season.

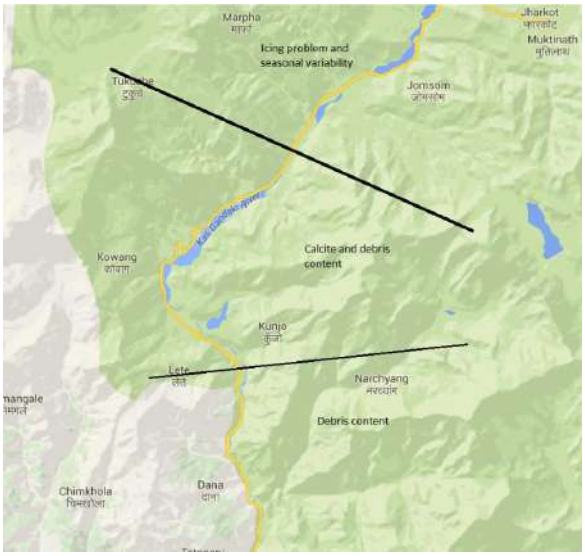

Figure 6: Divisions of the region (shown by dark line)

Photo1: Use of cotton cloth to filter debris and calcite.

South from this village has no calcite problem. There is still debris problem in almost all the villages. The water supply is from spring source and they have a regular supply for 24 hours. They don't experience much decrease in discharge rate even in the dry season. The village like **Ghasa**, **Dana**, **Narchyan and Tatopani** has the dense population among other villages. Every village is supplied by a single source and has 24 hours of supply throughout the year. The village with hotels uses the boiling and filtration techniques for the purification. Most of the villages now have regular supply because of the help from **British Gurkhas**.

Except for the villages like Kokhetanti and Titi, most of the villagers are satisfied with the quantity and quality of the water supplied to them.

5. DISCUSSION

Jomsom, despite being the driest part of the region, has the 24 hours of supply. This is because of it being the headquarters and

many important government offices and tourist hotels. The outskirt of Jomsom has a small population. Thus this region has not been in the eyes of the Government. Syang needs two sources but Marpha has thrice the discharge rate as of Syang. This is because the source of the Syang lies in the dry region with no trees but the source of Marpha is near to the glacier and is green. The debris content in the Tukuche and further south is due to the green trees, shrubs and loose soils in the source region. The calcite content in the Kokhethanti, Titi, Kunjo and Chhyo is because they are getting their water drained from Annapurna Limestone (Tethys-Himalayan Rock Sequence).

6. CONCLUSION

The survey was done from Jomsom, Mustang to Tatopani, Myagdi. There is seasonal variability in dry places like Jomsom, Syang and Chairogaun. Syang village needs to use the secondary source for the dry season. Other villages have low discharge during the dry season but enough to sustain them throughout the year. Except for the villages with lodges, they drink the water directly. The lodges and hotels use the filtered or boiled water for the visitors. Villagers use cotton clothes to separate the debris content and calcite. Kunjo village has a cm thick precipitation of calcite in a boiling pot in a week. They are getting this calcite because of their source water drains the Annapurna Limestone. Villages north of Tukuche experience the icing problem whereas south of Tukuche experience debris problem. In the conclusion, we can say that every village is getting their water from spring and almost every villager is satisfied with its quality.

ACKNOWLEDGEMENT

I am deeply obliged the Department of Geology, Tri-Chandra Campus for providing wonderful opportunity to work in the SIT program and providing platform to present the survey and its results.

I am thankful my friend Mr Ankit Dhakal who have assisted and encouraged me in completing this article. Heartily thanks for all my teachers and colleagues for helping me directly and indirectly for writing this article.

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About the Author of *Difference in the Drinking Water System along the Kali Gandaki Valley*

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Roll No.: 1205

Subject Combination: Geology, Botany, Zoology

Though I got my citizenship from Gorkha, I was born at Thapathali Hospital, Kathmandu, Nepal. I spent most of my childhood rolling over the dirt of Dhobichaur and my teenage running and carrying bats in the barren lands of Raniban. It's sad that my running days are over now. I did my SLC from Siddhartha Vanasthali Institute and +2 from Trinity International College. I was never an indoor since the time I remember and I always hated indoor jobs. So what's fascinating; where you earn visiting place and learn the nature around? First I was interested in Zoology and I chose Tri-Chandra College as I was told it has the best Professors and lecturers. In the very first few classes it didn't turn out good for me. Instead the history of the things around me began to fascinate me like how nature got developed over a period of long time. This curiosity in my mind, I devoted myself in the field of Geology.

I always wanted to know the perspectives of other people in doing things. They will not tell us in person but the books they write surely tell us about them. I always adore and respect **Bishweshwar Prasad Koirala**. His thoughts on the women and lust filled boys were inspiring to the society. He was able to write this because of imprisonment and away from love when he wanted the most. The quotation he gave in the book *Hitler ra Yahudi* is my favourite. "**The soul of the truth is words. The words are either the clever one or dull**." I am in love with the historical fictions from Diamond Shumsher Rana. It's very fascinating how he relates the historical happenings in his fictions. Among the foreign writer, I like Dan Brown and all his books. Since this book also relates historical facts with the fictional story, it is very worth reading. Fictional mystery novels from Sidney Sheldon always had me read it in a single fortnight. Among the sad novels, every book of Khaled Hosseini made my eyes filled with tears. Among the movies, *Scarface, The Dark Knight, The Godfather I and II* and *Fight Club* are my favourites.

I love singing, dancing, watching movies and travelling. I dream of stepping my feet at every districts we have. I think that everything we say or write reflects what we have experienced till that date. I do share my thoughts on WordPress (https://anishkhanal.wordpress.com/) sometimes. Writing makes me out of devil thoughts inside empty head. In future I see myself stepping in every district knowing my country, its inhabitants and the diversity in Himalayan Geology. For this I would need money. I see myself earning that money from the Geology. I hope that I will earn good to make my dream the reality.

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GROUNDWATER CONDITION AND SHALLOW TUBE WELL IMPACT IN TERAI (SPECIAL REFERENCE TO DANG VALLEY)

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ABSTRACT

Groundwater which is present beneath Earth surface in soil pore space and in the fracture of rocks is the important source of pure water in the earth. Groundwater is withdrawn for agriculture, domestic purpose, municipal and industrial use by constructing and operating extraction wells. It is the duty of human to check the condition of groundwater. The objectives of this study are to collect the information related to groundwater, tube well and its impact on production of crops. A field investigation was done to collect the required information. Dang is one of the suitable areas for the study of tube well impact. The establishment of tube well has positive impacts in agricultural field as well as in industries. Groundwater investigation and exploration has provided standard to the society in various ways.

Key Words: *Groundwater, Tube well impacts, Economic development, Agriculture*

1. BACKGROUND

Nepal being country of Himalaya covers only about 23% of total land as Terai part which is the plain area. Besides this area, there are some inner mountain valleys like Kathmandu Valley, Surkhet Valley etc which contains some part of the plain land. Groundwater exploration and its utilization are much more effective in these lands and also in some part of Siwalik zone of Nepal.

Dang Valley lies in the Mid-Western Region of Nepal which is one of the largest valleys in the South Asian region. It is bounded by Siwalik from three sides. The elevation of the valley floor ranges from 550 to 750 m. The study area is focused in the southern part of Dang Valley (Deukhuri area).

The terrain consists mainly of alluvium and outwash deposits from the hill slopes. The Rapti River and the Babai River are the main rivers flowing from north to south and east to west respectively. Other perennial streams which originate in the Lesser Himalaya and Siwalik zone join these two main rivers.

The climate of Dang Valley is Tropical to Sub-Tropical characterized by monsoon rainfall from June to September. (Uprety and Karanjac, 1989)

The field study was organized, financed and supported by the Department of Irrigation, Groundwater Resources Development Board, Babar Mahal, Kathmandu for the observation of the impact caused by the different shallow tube well clusters established in Dang Valley with the help of Indian Government.

2. OBJECTIVES

The main objectives of this field are as follow:

- To collect the technical information of tube well clusters such as:
  Depth of tube well
  Diameter of housing pump
  Aquifer level
  Screen type and length established
  Area covered (irrigated) by a single tube well
- To collect the information about the problem caused on the tube well clusters.
- To collect the information about the ways of water distribution to the consumers.
- To collect the information about the change that the establishment of tube well clusters brings, such as changes in the agricultural technology, the trend of cultivation, the crop production, manpower involved in cultivation

3. METHODOLOGY

The study method consists of two parts.

i. Desk Study
In this method, the field observer (me) and the supporter of the field study were stayed on a desk and discussed the normal outline about the geology of the area, its groundwater and the results that may come after field work.

ii. Field Study
In this method, the field observer (me) reached the site and studied about the different aspects of the groundwater and tube well clusters and its impacts on people in this area.

4. FIELD INVESTIGATION AND DATA COLLECTION

Groundwater has played an important role in sustainable development in many parts of the world by providing water for domestic, industrial and agricultural uses. In Dang valley, especially in the southern part, groundwater is the main sources of irrigation. Besides these, there are no other facilities of irrigation except in some few areas. Peoples in these areas were used to cultivate crops depending upon the rainfall so that there is no certainty of proper crop production.

The field investigation is focused in the area of Goberdhia which is in the southern part of Dang valley. The total number of investigated consumer committee in this area is 6. The total number of tube wells in this committee is 94. Each shallow tube well covers the area of 4 bighas of land for irrigation. The depth of the tube clusters ranges from 80 feet to 120 feet. The width of the housing pipe ranges from 3 inches to 4 inches. The aquifer level ranges from 30-50 foot. The screen length used in the tube wells ranges from 5 foot to 15 foot.

Random selection of the consumers was done for filling up the questionnaire including at least 2 members from each consumer committee. The totals of 25 consumers were involved in filling up the questionnaire for the impact study.

Among them, 90% of the consumers have the main source of income as agriculture. 30% of these consumers worked as a supplementary job. Other 70% of the consumer's family fully depends upon the agriculture. 10% of the total consumers have their main income source from other professions.

The main problem that is frequently faced by consumers is low voltage and irregular supply of electric power which is needed for the pumping of groundwater. Also, there is

lack of submersible pump. Only 35% of the consumers get their agricultural meter of electricity and 85% of the consumers used their own pumping machine for the irrigation.

5. RESULT AND DISCUSSION

The shallow tube well clusters constructed by GWRDB with the help of Indian Government has many positive impacts on consumers of that area. The people living in that area have started to think positively for the agricultural plan after the establishment of tube well clusters. Some of the people started to cultivate new crops and involved in agriculture making it as the main profession.

The crop production is also increased after the establishment of the tubewell clusters. The number of crops cultivated in a year increases from two crops to three crops in some areas. 42% of the consumers increase their crop number from two to three. The main crop that is cultivated in summer which is added after the establishment of the tube well is maize, paddy and vegetables. The production of the maize increases about 30-50% of the total production earlier. The production of the paddy increases about 10-20% of the total production and the production of the vegetable increases from 50-60% of the total production. Besides these main crops, the production of the crops such as wheat and oil crops has also increased to 20-30% due to the availability of irrigation facility from the tube well clusters.

6. CONCLUSION

Groundwater investigation and exploration is essential for the economic development of the people. Groundwater exploration directly effects on the crop production and other industrial production. There are lots of possibilities of groundwater exploration in all over the Terai region of Nepal and also in some dun valleys and some parts of Siwalik region. Proper utilization of the groundwater impacts positivity in the National GDP.

ACKNOWLEDGEMENT

My special thanks go to Mr Nir Sakya sir for the support in every step of the work. I am indebted to Mr Surendra Raj Shrestha sir for providing me with this opportunity. I am thankful to those people living in the study area, for their co-operative response. Finally, I am grateful to the 'Groundwater Irrigation Development Department" Dang for better coordination.

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I was born and grew up in Pawannagar VDC ward no. 03, Dang and currently staying in Dillibazar, Kathmandu. I completed SLC from Rapti VidyaMandir Awasiya Ma Vi, Tulsipur, Dang, Nepal. I completed +2 from Kathmandu Model Higher Secondary School, Bagbazar, Kathmandu.

Geology was totally a new subject to me, as I came Tri-Chandra Multiple Campus. I heard that it is one of the best subjects that are on demand. So, I decided to study Geology there. I must say that was the best decision I took at that time. I really enjoy studying Geology rather than other subjects.

I have captured many special moments in the department of geology. The most special moment was in Malekhu field work where I got a chance to view the world in the sense of geology and added a delicious flavour to my learning period.

The best book I have gone through is Jeevan Kaada Ke Phool by Jhamal Kumari Ghimire. The heart touching part of this book is her struggle for learning, live, and to be a good writer. She faced the very hard situation and had done very hard labour to learn a basic level of study, which is unbelievable and unforgettable.

Lastly, I would like to thank Tri-Chandra Campus, Department of Geology and our professors and lectures for providing deep knowledge, to fulfil my dream to be a successful geologist.

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THE CORE DRILLING

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Abstract: This article is totally about the core drilling specifically related with Hydropower. Not everyone is known to core drilling so I have put some details on the core drilling from what I have I have learned practically.

Key words: Lugeon, DCPT, Constant Head Test,

1. BACKGROUND:

Core drilling is basically done for knowing the subsurface and its properties. Before the development of any big foundation, it is necessary to know the subsurface. Without knowing the properties of the sub surface development of foundation leads to failure of the foundation.

There are various ways of determining the subsurface like Geophysical Method like Seismic Survey, gravity techniques, Electricity resistivity tomography, electrical resistivity, well logging, remote sensing etc. But core drilling by using the machines like rotary and percussion method gives a definitely clear idea of the subsurface. Core drilling is the prerequisites for development for the foundation of big buildings and hydropower construction. Core drilling gives the basic idea of the lithology of that place and we can know the fracture, joints, fault zone, bearing capacity of the place as well other geotechnical parameters and can have a clear idea of developing a strong foundation. Core drills are used frequently in mineral exploration also where the coring may be several hundred to several thousand feet in length. The core samples are recovered and examined by geologists for mineral percentages and stratigraphic contact points. This gives exploration companies the information necessary to begin or abandon mining operations in a particular area.

2. OBJECTIVES:

Core drilling basically deals with the following objectives:

i) To know the bearing capacity of the subsurface
ii) To find out whether place is fault zone or not
iii) To figure out the properties of the obtained core
iv) To know the stratigraphic contact points
v) To find out the depth of mineral availability
vi) To explore the properties of subsurface

3. METHODOLOGY:

Generally, Core drilling is done by Rotary Method for Hydropower. After choosing a suitable place for construction of the Dams, Surge tank and Power house for hydropower. Core drilling is done at those points. Along the equipment of the rotary machine like tractor engines, casing pipes, drilling bits, barrels are also required for drilling and core boxes for collection of the core samples. Not only the samples but some of the test is also carried out during the operation.

First of all, the rotary machine is setup on stage. Big pipe casing namely HX is used to give support to the barrel which is used to extract the core. The casing is used to prevent the collapse of the overburden. The rotary machine drills the casing inside the ground and the inside the casing barrel is adjusted and drilled. The process goes on and the casing is used until the bedrock is not encountered. The continuous rotation of the barrel collects the core sample inside it. The core samples are then collected in core box. Core box is generally a wooden box with a length of one meter with five partitions separated by a wooden plank.

Fig. 1 Core sample collected in core box.

The barrel is generally of two types, NX/ST and NQ barrel of 1.5 and 3m respectively. A lithological log is also prepared to figure out the properties of the core sample. Three tests are basically performed on the obtained core sample. They are:

i) Permeability Test

Permeability test by Constant Head Test is done for overburden material section of the drill holes. Lugeon test is carried out when bed rock is encountered.

a) **Constant Head Test (CHT):**

This test is done to know the permeability of the subsurface. This is generally done until bedrock is encountered. The constant head test is done at every 3m until bedrock is encountered.The depth of the water table is measured, the amount of water loss in the hole for a definite interval of time is also measured. The water level maintained at a constant height at predetermined mark/level in the hole. Variables like the amount of water consumption, the time taken for the consumption, the internal diameter of the casing, the diameter of the hole, excess head (height of water level from water table) etc are measured to derive the coefficient of permeability.

The coefficient of permeability "K" from Constant Head Test is calculated by using the following expression:

$K = Q / (5.5r * H)$

Where,

Q = Constant rate of flow

r = radius of the hole

H = constant head

b) **Lugeon Test (Water Pressure Test):**

Water pressure test is carried out by using a single packer in the drill hole. In this method, water flow is confined between the packer and the bottom of the test section. The purpose of the test is to obtain the permeability of the rock mass. Results can be used to assess the quantity of grouting material required to inject or to check the effectiveness of grouting or to predetermine the possible flow type along the drill-hole section.

The consecutive tests are carried at an interval of 3m in bed rock. The corresponding volume of water consumed is measured and recorded under each pressure stage, minimum two cycles of such measurement are carried for each test section.

Essential equipment such as water pump, flow meter and manometer, a single packer assembly is used for testing. Water, which is free of clay and other deleterious material is supplied during the test.

The lugeon value is calculated as follows:

$Lu = (10*Q) / (P*L)$

Where,

Lu= Lugeon value

Q= quantity of water injected, litre/minute

P = Effective pressure, kg/cm2

L = length of test section, m

P is calculated as;

$P = P_1 + 0.1(H_1 + H_2)$

Where,

P_1 = Pressure at gauze, Kg/cm2

H_1 = hydrostatic heads in meter between the pressure gauze and the ground level

H_2 = hydrostatic heads in meter between ground level and the centre of test section or between the ground level and water table whichever is smaller.

ii) Dynamic Cone Penetration Test (DCPT) or Standard Penetration Test (SPT):

DCPT test is generally done for overburden containing gravel and sands, whereas SPT is done for overburden containing only soil. For DCPT, a conical cone with an angle of 60° is used in the overburden material. Each time after extraction of the core sample, DCPT is carried out by assembling the cone at the depth on the tip of the drilling rod, a 65kg hammer is made fall freely from a height of 75cm which is fitted on the tip of the drilling rod. The hammer hits rod till it penetrates first 15cm but if hammering reach 50 times and it doesn't penetrate 15 cm then the DCPT value is marked as zero. But if within 50 times hammering if cone penetrates 15 cm then the number of hammering required to penetrate first 15 cm is counted. Again, for 2^{nd} and 3^{rd} 15cm penetration is carried out and counted the number of hammering. The count of 2^{nd} and 3^{rd} hammering will only be counted. Through this test, we can figure out the strong place for foundation development by plotting a graph of depth along DCPT values.

Similarly, SPT is done and instead of the cone, a spherical rod is used and the same process as DCPT is done.

iii) Lithological log:

After all the core sample are collected in core box, the samples are observed and a lithological log is prepared which includes the properties of a sample like roughness, weathering, infilling materials, orientation, the number of joints etc. As well, RQD and recovery percentage are also calculated in the log. But in the case of overburden, only recovery percentage is calculated.

Rest of the test of the core sample is done in laboratories like “Point load test”, “Uniaxial compressive strength” etc.

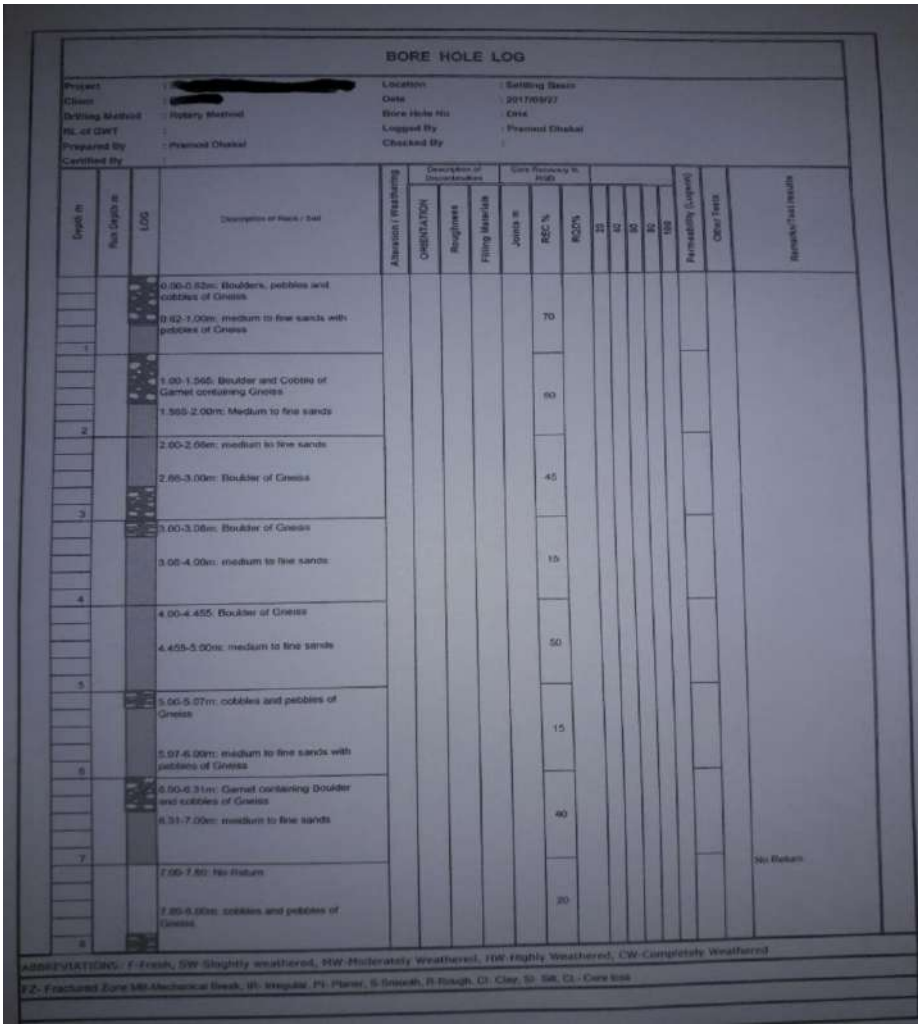

Fig: Lithological log

4) RESULTS:

After all the test done and the lithological log is prepared, a report including all the results and reports of the test are included in the report.

In this way, Core drilling is done and studied for development of foundations.

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About the Author of *The Core Drilling*

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Born in Kathmandu, Jorpati and from Morang, I have completed my SLC level from Shanti Adarsha Secondary School, Jorpati, Kathmandu and +2 from Madan Bhandari Memorial College, Binayaknagar. I was interested in engineering and tried for engineering but I was unable to get admission in Pulchowk campus. Then, planned to study physics and thought of developing a career in physics. When I entered Trichandra campus I was unknown about Geology but when I was told to choose the combination, I was in dilemma of choosing the combination. I was sure of studying Physics and Math but somewhere in my mind, Geology took place thinking of the opportunity to study a new subject. And at last, instead of physics, I chose Geology for my career. Studying Geology provided me lots of opportunities to know about the earth and its formation, Earthquakes, flood, landslides were no more new to me and learning from Geology was never enough for me.

When I entered Trichandra College, due to the presence of lots of leaders, I thought the environment will be political but when I went to the Department of Geology, I was totally impressed by the environment of Geology. Department of Geology is totally different and well managed than any other department of Trichandra College.

"If someone asked you to do something you don't know, then don't say no but instead say yes and then learn and do it" this quote has inspired me a lot throughout my career. After giving exam of BSc fourth year in geology I was offered a job to work as a Geologist in core drilling. As I was new to the field but I accepted the job and learned about the work. As I am engaged in core drilling, my article is also related with Core Drilling and hope it has helped you too.

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CORE DRILLING FOR LIMESTONE QUARRY

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Abstract
This article base on the geotechnical investigation (core drilling) located along northern eastern hill slope of Trikhandi. Drilling method is widely adopted at present in geological exploration also. The main aim of the drilling is to obtain the information about the subsurface condition, structure morphology and quality of the deposits of the quarry area. The surficial and underground exposure consists of slightly to moderately leeched/weathered, massive to blocky Marble with well-developed calcite crystals along the solution cavities and joint plane. The bedrock of Marble is encountered at shallow depth (< 0.50m). Overall core recovery is 64%, the minimum being 20% and maximum 98%. Free fall during drilling up to 15cm is frequent, suggesting the existence of cavities measuring up to 15 cm in diameter.

1. BACKGROUND

During both preliminary and detailed exploration, underground mining works and drilling are used. Underground working is expensive and technically demanding; they are used where drilling cannot provide a sufficiently precise picture of the complicated structure morphology and quality of the deposits. On such deposits, most exploratory systems utilize underground mining works and drilling. Drilling method is widely adopted at present in geological exploration. Effetely Modern drilling rigs/bits make it possible successfully with problems that have so far been insoluble, as, for example, the deciphering of deep geological structure or the search for hidden deposits. When intelligently applied exploratory drill holes lower the cost and time of exploration. A core drill is a drill specifically designed to remove a cylinder of material, much like a hole saw. The material left inside the drill bit is referred to as the core. Core drilling is at present most widely used in the exploration of solid mineral materials. The advantage of this method is that it yields detailed geological information and often enables reliable sampling provided core recovery is satisfactory.

2. OBJECTIVES

The principle objectives of the drilling operation are to obtain the information about the subsurface condition, structure morphology and quality of the deposits of the quarry area and to retrieve core sample as its maximum for assessment of its quality and cement grade.

3. METHODOLOGY

A desk study was conducted by studying past reports, articles and journals published on the topic above before departing to the field. Core drilling activities had run by the **Shivam cement** for a limestone quarry.

4. RESULTS AND DISCUSSION

4.1 Borehole Location

The location of drill holes was ascertained with the help of portable GPS and base map in hand. The decision regarding the location of the drill hole and the orientation of the drilling and related matters were finalized in mutual consent with the representative geologist and the team at the site. The drill hole is oriented in such way that the drilling axis remains perpendicular to the prevailing attitude of foliation plane. For the present investigation, the drill hole was adjusted at

an angle of 45° to the horizontal with azimuth 245º.

4.2 Core Drilling

Core drilling was carried out as per IS Designation standard procedure using a conventional drilling rod and rotary coring accessory with wire line facilities. The drilling had been done using the diamond bits of NQ size, core barrels were of double and triple tube swivel type with the retrievable inner tube. Clean water was used as drilling fluid to flush out the rock cutting sludge. The casing of appropriate diameter is simultaneously inserted as depth advances in case of the collapse of hole wall or water loss.

Average core recovery is **64%** and the minimum core recovery of **20%** and the highest core recovery was **98%**. Relatively high percentage of core recovery is obtained in the horizon between **3.00-4.00m**.The rocks after **10.20 m** depth, thin to medium schistose/phyletic partings appears.

Table 1: Summary of Drill hole (Source: Drilling company)

S. No.	Drill hole	Bearing Angle	Drill angle from Horizontal	Coordinate		
				X	Y	Z
1	DH-11	245°	45°	390377	3117394	1555

4.3 Core logging and Core Box Arrangements

Immediately after retrieving the core, the product of drilling activities core is arranged in a systematic way in core boxes with the proper partition of the run depth. The core boxes are properly marked and marking for each run depth in the form of partition is done. The core pieces are thoroughly observed and are described for its properties. During the present drilling operation, total core boxes were arranged and handed over to the representative in the field. Arranged core boxes photographs are presented.

4.4 Geology of the Quarry Site

Geologically, the quarry area consists rock unit of Markhu Formation belonging to Bhimphedi Group of Kathmandu Complex (Stocklin and Bhattari, 1980). In general Markhu Formation consists of coarse to medium grained crystalline marble changing to dark finely biotitic schist inter-bedded with impure marble and quartzite. General dipping of the limestone of that area is NE to NW with varying dip angle (up to 75°) indicating the folded nature of the rock.

Fig. 7 Arranged core boxes and instruments

5. CONCLUSION

The bedrock of marble is massive to blocky in nature. Well grown calcite crystal is abundant in surficial outcrops and within the solution cavities as observed in the core retrieved during drilling. The average penetration rate during drilling is 1-2 cm per minutes with an even higher rate of penetration highly calcified zones with calcite veins and solution cavities with recrystallized calcite. The zone after crossing certain depth the rock type observed consists of impure marble with intercalation of schistose rock of phyllitic rock. During drilling activities free fall of up 15-25 cm was frequently, the free fall zone greater than 20cm occurs at a certain interval not exceeding 50cm, suggesting smaller cavities. By collecting more and more information we interpret about the reserve estimation, complicated structure, morphology and quality of the deposits.

ACKNOWLEDGEMENT

I am thankful to my Tri-Chandra College, Department of Geology for giving me the opportunity to write an article. I express sincere gratitude to Dr Tara Nidhi Bhattarai for all kind of encouragement to write this article. I would like to express my appreciativeness to drilling company to give me a chance to visit the working site. I would like to thank all the members of the editorial board for their valuable comments and advice. Similarly, I would like to thank all others teachers of Geology Department and my colleagues to encourage me to write the article.

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About the Author of *Core Drilling for Limestone Quarry*

Year of Admission: 2070 BS

Name: Ishwor Dahal

Roll No: 421

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I was born in Namdu V.D.C. ward No, 1, Dahaltar village, Dolakha. I was migrated to Kathmandu with my parents at the age of 3 years. I attended Saraswatikunj Higher Secondary School, Ratopul, Kathmandu and completed +2 from Oliver public Secondary School, Kathmandu.

I love adventure, travel and photography. Music is my passion. And I love playing football, **Jivan Kada ki phool** by **Jhamak Ghimire** is the book that inspired me the most.

I was doing my Pre-Engineering classes at SEA Institute. From a friend of mine as well as my elder brother, I came to know about Bachelor in Geology. My entrance exam went good and the subject was my choice, I got admitted to the college. The environment at the college was friendly and I come to meet many friends. I remained centred on Geology subject and purchased extra know-how approximately it. The most exciting issue about geology turned into it is a field-based study and totally multi-disciplinary study and the thing that stored my eye on it changed into how it explained the earth records early from its beginning, Geological history and phenomenon that is answerable for the existing and it‘s exquisite.

The most unforgettable event during B.Sc. first year was my first meet with Prof. Dr Bishal Nath Upreti and Prof. Dr Tara Nidhi Bhattarai. I had heard a lot about them before coming to Tri-Chandra College. It was a matter of great pleasure to meet such iconic geologist and one of the pioneers of Nepal Himalayas. Studying geology up to four year became even extra charming due to subject works, occasional lectures via renowned geoscientists, a workshop on "underground excavation" and many other instructional slides, documentary prepared by means of the department. For the duration of the third year observed geological mapping physical activities attracted me lots. It was an indispensable tool to realize how rock sorts in types and geological structures are converting horizontally and vertically in a place. This records performs an important role now not simplest to understand the natural system that occurred in the past and presently prevailing now, but additionally to layout diverse infrastructures in an environmentally friendly way.

Considering the fact mentioned above and also based on my own wisdom, I want to be good engineering geologist within next 10 years.

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LANDSLIDE CASE STUDY

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Abstract:

A landslide is a movement of rock debris of earth flow a slope. They result from the failure of the materials. Which make up the hill slope and are driven by the force of gravity? The failure of the slope happen when gravity exceeds of the earth materials in the world there are various types of landslide occur, a landslide is very harmful for nature, so we have to know and how to minimize the effects of landslide.

1. BACKGROUND

Landslides are known as the landslide slumps or slope failure .Landslide can be trigged by natural causes or by human activity. They range from a single boulder in a rock fall or topple to term of mileages of citric of material in a debris flow. The movement of slope forming material along the surface of separation by falling, sliding, and flowing is called landslide activity.

2. OBJECTIVES

- To understand Geology as well as rock type of selected area.
- To learn cause and reason of landslide Develop in such area.

3. METHODOLOGY

- Information was collected through secondary sources such as books, articles, project reports, website etc.
- Field visit for measurement of discontinuity.

3. FIELD INVESTIGATION

The landslide inventory data was taken from Bhalebas village which lies in the Palpa District of Nepal. The name of the landslide is given according to the type locality. So the name was Bhalebas landslide is given according to the type locality so the name was Bhalebas landslide. The observation point lies in the 83 [31' 58.732" E] Latitude and 20 [48'54.817"] N Longitude. The observed landslide was natural slope which was linear at first also called natural state and the lines perpendicular to contour lines ware parallel. The inclination of undisturbed slope was about 25^0 which were oriented at south-east direction. The landslide area was covered with forest and no any infrastructures are observed except road around the Bhalebas Landslide.

The Bhalebas landslide is rotational on the lower but translational on the upper part. The activity of this landslide was dormant and reactivated which was on its intermediate stage. The major feature such as gully and stream and erosion was observed in this site. The observed soil was colluvial with gravel slit type. The rock type of this formation belongs to metamorphic which was obliquely laminated. Light grey colored slate. The maximum thinker of weathered rock was thin
which
was variable but not folded. The type of discontinues of this landslide were cleavage plane and joint plane.

Fig. 1 The Bhalebas Landslide

4. CAUSE AND MECHANISM OF FAILURES:

Some slope is susceptible to landslide where as other are more stable. Much factor certitude to the instability of slopes but the main controlling factors are the nature of the underling bedrock and soil the configuration of the slope the geometry of the slope and ground water condition.

- Intrude or prolonged rainfall rapid snowfall or sharp fluctuation in ground water level.

The observed landslide is dipped towards south-East with dip around 47 lakh variables. The geological cause of this landslide is continual reduction of shear strength by weathering and progressive failure etc. Mapping is done to trace out the landslide and its conditions.

Three distinct physical events occur during a landslide the initial slope failure the subsequent transport and the final deposition of the slide material landslide can be triggered by gradual process such as weathering or by external mechanism including.

- Undercutting of a slope by stream erosion glacier or human activity such as road building.

5. RESULT AND DISCUSION:

Field observation showed that the sliding materials mainly composed of brown to yellow colored completely colluvium soil. The composition of the sliding materials of the landslide is boulder gravely soil with significantly fines. Rice cultivation and over grazing of the area should be discouraged.

6. CONCLUSION:

When occurred, landslides cause's great losses to both human and infrastructure. RS and GIS based hazard zonation maps accurate information about the risk levels in a particular area.Many hilly region in Nepal have weak geographical formation along with steep topography.

ACKNOWLEDGEMENT

I am thankful to my Tri-Chandra college, department of geology for giving me the opportunity to write an article. I express sincere gratitude to Dr Tara Nidhi Bhattarai for all kind of encouragement to write this article. I would like to thank all the member of editor board for their valuable comments and advice.

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About the Author of *Landslide Case Study*

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I was born in 2053/02/14 at Shankharpokhari-04, Parbat. My first school was Shree Mahadav Primary School, where I completed my Primary level education. But passed my SLC exam from Shree Janasayogi Higher Secondary School, Shankharpokhari with first division then I completed +2 level from Shree Narayan Higher Secondary School, Kusma. For my bachelor degree class, I came to Kathmandu and admitted at Tri-Chandra College because this collage is very famous for its good education especially in science subject. I had chosen GPM combination and in my third year I was interested to read Geology. Therefore, I had chosen Geology for my major subject.

When I started to read my first year that time I felt very difficult because I was totally unknown about the subject of Geology but gradually in 2^{nd}, 3^{rd} and 4^{th} years, I was really inspired by the subject Geology and I only concentrated on my study .In my college time the most memorable moment were educational tour of Malekhu and Palpa. Where, I gained a lot of practical knowledge from my teachers and friends, they helped me in my problems.

While I started 4^{th} year I was so inspired by Engineering Geology because I got a lot of information about the different structures that are present in the rock. It effects during the construction of large structures like; road, dam, tunnel or during the extraction. I hope I will choose Engineering Geology in my further study as well as in master level and one day I will be a good Engineering Geologist.

In my other hobbies, I am also interested to read novels and to watch movies. The best book I have ever read is Muna Madan, written by Laxmi Prasad Devkota. The book conveys the message that a person would be respectable by their generosity not by their caste.

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LANDSLIDE ZONATION MAP ON THE BASIS OF FAILURE ANALYSIS

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Abstract
Slope failure is all because of its weak geology and physiography of slopes, combined with triggering factors such as heavy monsoon rainfall, cloudbursts, and earthquakes. Triggering factors varies with different physiographic, geologic, and climatic zones. Kerunge landslide area represents a part of the Mahabharata Range, immediate north-west of the Siwalik. Geologically, the area belongs to the Lesser Himalaya (Sakai, 1983), immediate north of the Main Boundary Thrust (MBT). Basically, the major rock types of Lesser Himalaya such as Quartzite, Shale, Marble, and Gneiss are observed. Kerunge landslide is the major cause for the loss of life and properties. Due to the weak geology in this area landslide occurs. A landslide zonation map is prepared based on the material type involved, facet, and type of slide and relative hazards. Kerunge landslide area was divided into eight zones on the basis of type of material, type of movement, identical geomorphic features and hazard type.

Here the geology of the Kerunge area was interpreted and the landslide zonation map was prepared on the basis of failure analysis.

Keywords: *Landslide zonation map, Lesser Himalaya, MBT, Failure analysis.*

1. BACKGROUND

Landslide occurrences in Nepal is a function of the inherently weak geology and physiography of slopes, combined with triggering factors such as heavy monsoon rainfall, cloudbursts, and earthquakes. These factors vary in different physiographic, geologic, and climatic zones. It is not a better way to use a uniform approach to the study and mitigation of landslides hazards in every zone of the Himalaya. Each zone of the Himalaya exhibits a unique feature in regard to lithology, structures, deformation, weathering, drainage and other land use related parameters. A better understanding of the geologic, physiographic, and climatic zones and their combined overall effects on the terrain is a prerequisite for any successful project of landslide study and mitigation in Nepal.

The Kerunge landslide (Fig.1) is located at Hupsekot-5 of Dauwadi VDC in Nawalparasi district. The area can be identified as $27^0$46 '4.843"N and $84^0$6'26.735"E GPS co-ordinates in western Nepal.

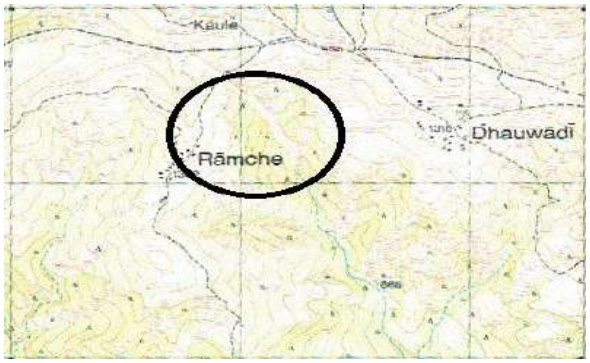

Figure 8 Topographic map showing the study area of Kerunge landslide inside the circle (source: www.pahar.in)

Physiographically, the area represents a part of the Mahabharata Range, immediate north-west of the Siwalik. Geologically, the area belongs to the Lesser Himalaya (Sakai, 1983), immediate north of the Main Boundary Thrust (MBT). The Dewachuli hill (~ 1900 m height) is the prominent high land near to the present landslide area. One can reach the landslide area by mountain riding jeeps and mini-buses.

2. OBJECTIVES

The Kerunge landslide is responsible for the severe loss of life and property. Therefore, it was felt necessary to carry out this study to come up with some sound and sustainable technical measures to stabilize the landslide. Consequently, the main aims of the study were the following:

i. To prepare the landslide zonation map on the basis of slope stability analysis.
ii. To make some immediate recommendations for the purpose of protecting the village from the landslide.

3. METHODOLOGY

Before starting the field analysis, desk study was done. Relevant articles, journals, magazines on Kerunge area that were published previously were gathered. After studying theoretically direct observation was made for the primary data collection. The Kerunge landslide area was then traversed; there the attitude of beds were measured, rock samples were collected and the photographs taken. To traverse in and along the landside areas, help of the villagers was sought for. The shortest route to traverse to the actual location was pointed by a villager. We were also helped by him in recognizing failure slope clearly. His knowledge on the rock fall area was also helpful in understanding the nature of landslide.

Furthermore, the slope stability was analysed from the collected the data and zonation map was prepared on the basis of collected data and information.

4. RESULTS AND DISCUSSION

4.1 Landslide Zonation Mapping

Landslide zonation map was prepared based on the material type involved, facet, and type of slide and relative hazards (Fig.2). Material characteristics and geomorphic features of each zone are shown in Table 1.

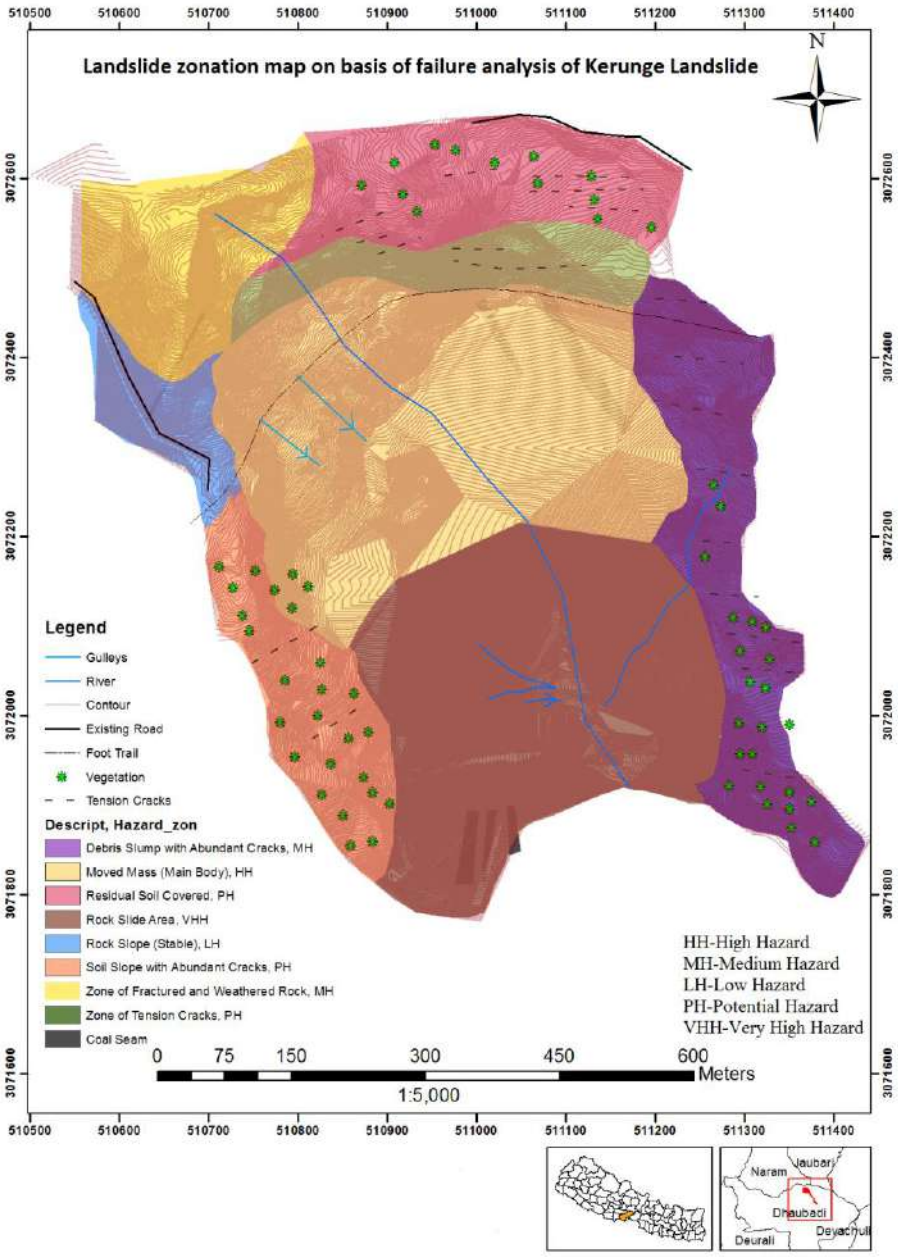

Fig. 2: Landslide zonation map on the basis of failure analysis of Kerunge landslide

Table 1. Material characteristics and geomorphic features of each zone (from Fig.2).

	Name of zone	**Dimension**	**Rock type**	**Type of failure/ stability condition**	**Soil type**	**Soil depth (approx)**	**Ground-water/ surface water condition**	**Vegetation covered**	**Mitigation Measures**	**Tension cracks**	**Relative Hazard Classification**
1	Rock slide area	L-50m B-30 m	Shale+ quartzite (4:1 ratio)	Plane failure	Residual + colluvium soil	0.5m	Dry	Low to none	No	Somewhere	Medium Hazard
2	Debris slump with abundant cracks	L-12m B-2.m	Shale	Soil failure (soil slide, debris slide)	Residual + colluvium soil	1.5 m	Moist	High	No	Many	Medium Hazard
3	Soil slope with abundant cracks	L- 9m B- 3m	Bed rock is not exposed anywhere	Soil failure (debris slide)	Residual + colluvium soil	2m	Dry	High	No	Few	Potential Hazard
4	Zone of fractured & weathered Rock	L-20m B-16m	Fractured quartzite with partings of shale	Wedge failure	Residual soil	1m	Dry	Medium	No	Many	Medium Hazard
5	Residual soil covered	L-25m B-19m	No	Soil failure	Residual + colluvium soil	1.75m	Dry	High		Excessive	Potential Hazard
6	Zone of tension cracks	L-15m B-20m	Boulder (quartzite)	Soil failure	Residual	2 m	Spring activate at rainy season	Medium	Bio-engineering	Excessive	Potential Hazard
7	Moved mass (Main Body)	L-18m B-20m	Boulders of quartzite and fragments of shale with coal powder	Soil failure	Colluvium soil	1.5m	Spring activate at rainy season	No	Gabion wall	No	High Hazard
8	Rock slope	L-20 m B-25m	Intercalation of shale and quartzite	Plane failure	Colluvium soil	0.5m	Surface water (running water)	No	No	No	High Hazard

5. CONCLUSION

The major cause of landslide is the adverse combination of rock types, deformed and fractured rocks and steep slope. Intense deformation on rocks might have been caused by the MBT which is immediate south from the landslide area. Whole landslide area can be tentatively divided into eight zones as landslide zonation. The zonation is categorized on the basis of type of material, type of movement, identical geomorphic features and hazard type. Out of these zones, two are categorized as very high to high hazard, two as medium hazard, one as low hazard and the rest three as potential hazards.

ACKNOWLEDGEMENT

I would like to thank Dr. Kabiraj Paudhyal to provide me the opportunity to do field work in the landslide area. I would like to thank my friend Mr. Pranjal Poudel for helping to make my article better. I express my gratitude to the Department of Geology for giving me an opportunity for writing an article. Finally, I am also thankful to Prof. Dr. Tara Nidhi Bhattarai for inspiring to write an article.

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About the Author of *Landslide Zonation Map on the Basis of Failure Analysis*

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Born in Majuwa, Gulmi, I attended Shree Gyanodaya Higher Secondary School, Turang-01, Majuwa, Gulmi and completed the intermediate (+2) from Orchid Science College, Bharatpur, Chitwan. Knowing information about geology from a friend, I admitted in Bachelor Level for B.Sc at Tri-Chandra campus.

I was keen to read geology and attended most of the classes, both practical and theory, during my two years in the college. Although I have learned many fascinating knowledge of Geology, I was much delighted to know that a grain of sand can tells us a long history starting how a rock was formed in a deep sea, exposed to atmospheric environment and subsequent erosion. Origin of life from micro-organisms to the million years of geological changes in the Earth's history fascinated me a lot. Geology gives me the idea of Earth's history from nothing to something.

Studying Geology in 3rd and 4th year was even more fascinating because of field works**.** During my study, geological mapping exercises attracted me a lot. It was an indispensible tool to know how rock types and geological structures are changing horizontally and vertically in an area. This information plays an important role not only to understand natural process that occurred in the past and presently prevailing now, but also to design various infrastructures in an environmental friendly manner.

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APPLICABILITY OF Q SYSTEM IN TUNNELING PRACTICES

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Abstract

Since its development in 1974, the Q system for classifying rock masses has readily been used for dimensioning support measures in underground excavations. This paper describes the details of the Rock Tunneling Index and its parameters along with rock type, geological structures, discontinuities properties, water conditions and ground behaviour for tunnel support design and suitability analysis of stability which can be compensated using Q parameters and Q value.

Keywords: Q system, tunnelling, support, stability

1. INTRODUCTION

In the last decades, rock mass classification concept has been applied extensively to engineering design and construction. Rock mass characterization is normally carried out through the application of empirical classification systems which uses a set of geotechnical data and provide an overall description of composition, strength, deformation properties and characteristics of rock mass required for estimating support requirements, stand up time and also shows which information is relevant and required (Bieniawski, 1989).

Mostly, for underground construction rock mass classification systems used are RMR, Q system and GSI. This paper outlines a method to combine the geological, geotechnical and structural aspects of rock mass using Rock Tunneling Index, Q system for determining rock mass rating and estimating and designing support requirements. Rock mass rating and design estimation along with modification in parameters along with temporary and permanent support for tunnel construction are presented.

2. OBJECTIVES

- Defining Rock Tunneling Index Q system and its parameters with uses in tunnels
- Estimating and assigning support design based on Q value for temporary and permanent support

3. METHODOLOGY

Various papers were reviewed concerning Rock Mass classification systems, Tunneling mechanics highlighting on Q system for tunnel excavation, rock mass rating and support. A field study was done by preparing geological mapping, discontinuity analysis and implementing Q parameters in tunnelling in Lesser Himalayan metamorphic zone near MCT in Rasuwa. Identifying significant parameters that affect the behaviour of the rock mass, dividing into quality, defining the basis of characteristics of each rock mass class, deriving quantitative data and critical analysis formed an indispensable part of the proposed study.

4. RESULTS

Rock mass quality, dimensions of underground opening and safety requirements are dependent factors for support and satisfactory stability. For rock mass evaluation and as documentation, geological mapping describing general geology, discontinuity, and ground water condition is required. Using a classification system ensures that the description will be more systematic and uniform which will facilitate comparison between different locations.

The Q system is the most frequently used and best-documented classification system for rock masses. The Q equation is built up from RQD (Rock Quality Designation), the number of joint sets (J_n), joint roughness number (J_r), joint alteration number (J_a), water conditions (J_w), Stress Reduction Factor (SRF).

$$Q = \frac{RQD}{Jn} * \frac{Jr}{Ja} * \frac{Jw}{SRF}$$

Individual parameters are determined during geological mapping using tables described by Grimstad and Barton (1993) which gives numerical values to be assigned to a described situation. The degree of jointing (RQD/J_n), Joint Friction (J_r/J_a), and Active Stress (J_w/SRF) are analyzed by Q system for defining rock mass stability and assigning support design.

a) RQD

In the tunnel, all types of fractures affecting stability are taken into account in calculating RQD. Fractures induced by blasting and natural joints are considered. Also from a number of joints per m^3 RQD is calculated i.e. RQD=115-3.3J_v (Palmstorm, 1975). Its value ranges from 0 to 100. Where RQD is reported as < 10 including 0, value 10 is used in evaluating Q.

b) Joint set number

Parallel joints occurring systematically with characteristic spacing are called joint set. It defines shape and size of blocks in the rock mass. An evaluation must be made as to how much persistency and spacing of joint set contribute to block fall in tunnel opening. For tunnel intersection, J_n is multiplied by 3 whereas for portals multiplied by 2.

c) Joint roughness number

Joint friction is dependent on the character of joint walls if they are undulating, planar, rough, smooth, irregular, slicken sided. It is described as rock wall contact and no rock wall contact when sheared. If the infill is thick, J_r is treated as no rock wall contact. In determining J_r, the most unfavourable joint set is considered.

d) Joint Alteration number

The thickness and mineral composition of infill affect joint alteration. In determining J_a, it is divided based on infill thickness as rock wall contact, rock wall contact before 10 cm of shear deformation and no rock wall contact during shear deformation.

e) Joint water conditions

Water leakage or seepage is considered along with water pressure in this. Water reduces normal force on the joint wall and loosens infill and might outwash infilling. This value can be increased by prevention of water leakage by application of grouting.

f) Stress Reduction Factor

It describes the relationship between stress and rock strength around the tunnel. It is calculated from rock uniaxial strength and major principal stress. Overburden, weakness zone, competent rock, squeezing rock and swelling rock analysis is done while measuring SRF.

5. DISCUSSION

The calculated Q value and six parameters values that comprise it can be used to determine safety measures needed for that given value as shown in Fig 1.

Support estimates before/during/after excavation give different volumes of rock support. However, observed characteristics are used to estimate conditions for planning without including the input of excavation method. Important in all rock and tunnel analysis is a sound understanding of the geological formation, composition of rock mass at the site, their intact rock characteristics, joint density, pattern, rock stress, groundwater, local/site geology, ground behaviour. Temporary support is installed at/near tunnel working face and later additional permanent support is installed to ensure proper functioning of tunnel throughout its lifetime.

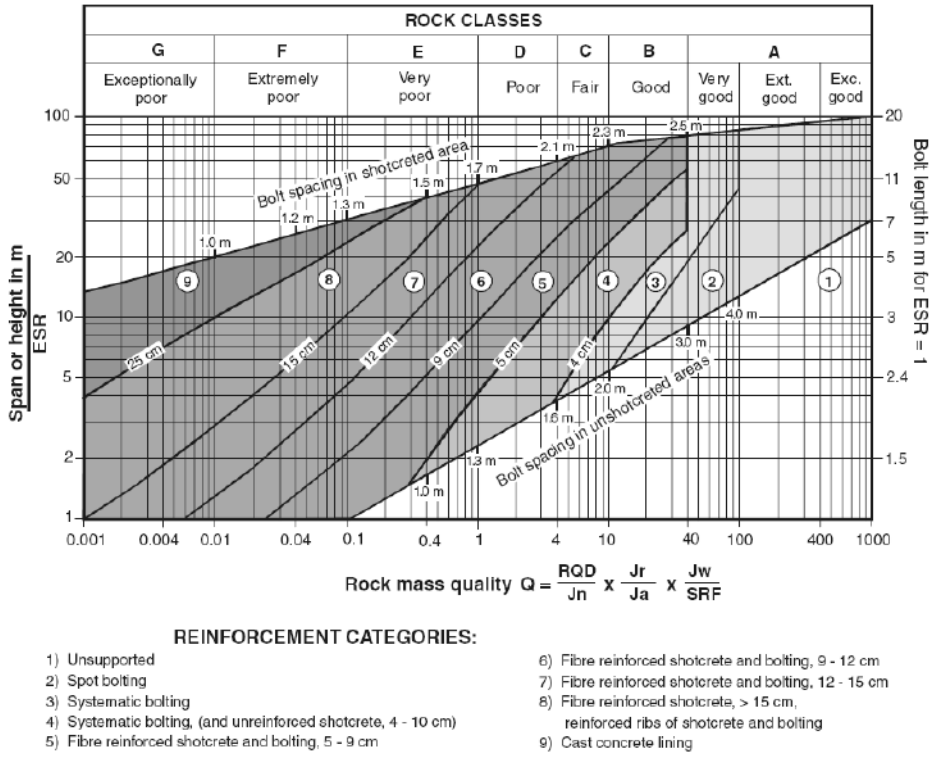

Fig 1: Estimated support categories based on the tunnelling quality index Q (after Grimstad and Barton, 1993)

Table 2 Exacavation Category

Excavation category		ESR
A	Temporary mine openings	3-5
B	Permanent mine openings, water tunnels for hydro power (excluding high-pressure penstocks), pilot tunnels, drifts and headings for large excavations	1.6
C	Storage rooms, water treatment plants, minor road and railway tunnels, surge chambers, access tunnels	1.3
D	Power stations, major roads and railway tunnels, civil defence chambers, portal intersections	1.0
E	Underground nuclear power stations, railway stations, sport and public facilities, factories	0.8

6. CONCLUSION

Rock Tunneling Index, Q system is meant to assist in estimating conditions of the rock mass. This system allows estimating rock mass strength and deforms ability through homogenizing the influence of discontinuities and the intact rock into pseudo-continuum. Geotechnical engineer or engineering geologists should apply theory and experimentation but temper them by putting them into the context of the uncertainty of nature. For economically viable tunnelling, it is crucial to have a method characterized by cost effectiveness and flexibility to adapt to changing ground conditions and by accuracy in prediction of rock mass quality during planning. Although this system gives a rational and quantified assessment, they guide rock mass characterization process and assist in communication but there is room for improvement in this system.

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I would like to take the opportunity to thank Dr Tara Nidhi Bhattarai for giving us the opportunity to create and write this journal. A thank is definitely in place for Ankit Dhakal for going through the draft of this paper. I would also like to thank Lower Sanjen Hydroelectric Project for giving the opportunity to enhance more on Q system and tunnel support design.

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About the author of *Applicability of Q system in Tunneling Practices*

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I was born in Chormara, Nawalparasi. I passed my SLC from Nawalpur Secondary English School and completed my +2 from Aroma Higher Secondary School, Bharatpur, Chitwan. After my HSEB, I prepared for medical entrance for one year but I could not get enlisted in the scholarship quota in the medical entrance. Then, I joined Tri-Chandra College so my next year would not go non-academic. I was filling admission form and I asked my friend who was studying in the first year to suggest me a better combination to study and I ended up filling the form with the combination GBZ.

Remembering my days in Tri-Chandra reminds me of the first class in botany where I got introduced with Bimal, Prafulla and Aakash. Surprisingly all of us had lost our one year trying to get admitted in other faculties and streams but ended up in Tri-Chandra. The unforgettable moment during my Bachelor's study is the turning point in my life that I cancelled my visa processing for Australia and choose to study geology in Tri-Chandra College. I find the subject more interesting and find myself enjoying it. Studying geology in the fourth year is fascinating because of all the applied courses and field work covering engineering geology, hydrogeology, mining and exploration geology.

Besides geology, I love listening to music and reading the autobiography of the unsuccessful persons who were once successful. I am inspired by a quote, "Someone's opinion of you does not have to become your reality, so believe in yourself". I want to be the best in what I could do in the near future.

SECTION C: ESSAYS

This section consists of essays that emphasise on

- The questions that need to be researched in the future
- Scope of Geology
- The importance of study of geology from the high school

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FEW RIDDLES THAT NEED TO BE SOLVED

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If I am to answer the question "what is it that is driving the whole human race?" in terse I shall reply "The quest, quest of knowledge". Scientists and Philosophers are in constant search since time immemorial, searching for the point that shall unify and answer all of the questions regarding the existence of this nature and universe. And taking part as one of the members of this huge global family of human civilization, my dear friends I have presented here some of the riddles that have always been tickling me. And if we can add even the slightest hint for these, then it shall be the great boon for the scientific community. And I don't think we cannot, for it is none other than the geologist, who dares to turn over the pages of the Earth and gaze into the abyss of mysteries.

Primordial Earth:

According to **Solar Nebular hypothesis** - the most widely accepted hypothesis regarding the origin of the solar systems solidified dust and the gases left over from the creation of the sun led to the initiation or the genesis of the Earth including other planets as well dated around 4.6 billion years ago. But still, there are lots of discrepancies and gaps in the hypothesis regarding the formation of Earth. From the huge fiery ball on its way from dust, gas and fire to liquid and then to become the stable solid planet today, planet earth has witnessed so much of events that might seem as the plays of the mysteries for a human. Among them, one of the most puzzling one for the geoscientists is the Origin of water. It is very hard to give the solid conclusion regarding this. One group of scientists affirm that the planet was formed as a wet planet with water on the surface. Yet, another group argues that since water would all get evaporated from its hot surface during the very early phase of the earth, water arrived here lately from comets and asteroids at the time when the earth was subjected to heavy bombardments.

Riddle: So, when and how did the Solar systems form? And how actually did all these enormous volumes of water on earth come from?

Life:

One question that has driven the whole of the humankind with immense curiosity is, "What is life and how is it here?" Let all the philosophers and saints describe the life from beyond the physical realities but as an inquirer, I can't withhold asking myself how on Earth did life first appear?

Describing the life of single-celled bacteria which is predominantly regarded by almost all of the scientists as the first life form to have originated in earth is not as simple as the term single-celled sounds. The organic molecules in themselves are so complex, and the self-replicating molecules like RNA and DNA are probably one of the most complex structures discovered yet. Enclosing of these molecules within the cell

membranes, the evolution of the metabolic process and overall functioning of the cell is in itself mind-blowing. And apart from this, what still remains intriguing is the evolution of multicellularity and the differentiation and evolution of the opposite sexes. There are different hypothesis proposed till today but none of them has definitely solved the mystery: "*The Origin of Life*"

Riddle: How was the life initiated at first and how did it thrive? How did the sex differentiation take place?

The flipping of the Earth's Magnetic Field:

Earth can be named as a big natural dynamo because of its electromagnetic properties. According to the scientists, rotation of the earth on its own axis is the cause for its generation of the electromagnetism. The inner core of the earth is made of solid iron which is surrounded by a molten outer core. When the earth spins on its axis, its solid inner core spins with the rate different than the iron-rich liquid outer core. According to the scientists, this is the reason behind the generation of convention's and currents within the core, and also the magnetic field.

Currently, the geomagnetic North Pole and the geographic North Pole are almost in the same direction and so are the south poles. Geographical poles always being the same, it is interesting to know that the Earth's magnetic poles interchange their polarity in the due course of earth's history. Its North Pole and South Pole flip over i.e. the North Pole flips to south and the South Pole to the north. Study of the sequences of the sedimentary and igneous rocks is carried out to identify this flipping of the geomagnetic polarity in the past. Paleomagnetic studies have found about 170 magnetic pole reversals within the last 100 million years. According to them, the last major reversal occurred in between 700000-800000 years ago.

Riddle: What is the cause behind or in another word, the stimulant for this reversal?

About the author of *Few Riddles that Need to be Solved*

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Narayanpur, Chitwan is my native place and Sunrise English School my home where I was provided with immense opportunities to boost up my curiosities. I am still longing to join my school, those serene beauties of gardens and groves and that grand library where I spent most of my time during grade 9 and 10. And for higher education (grade 11 and 12), I joined Capital Higher Secondary School. To be honest, most of the teachers there acted merely as an oppressor of curiosity and passions. I regret Nepal despite having the plentiful Newtons and Einsteins; all of them are forced to get pruned in the same and single machine.

During my period of High schooling, I was so addicted in exploring the physical world that I had decided to pursue my higher studies in Physics. But misfortune was endured to me so much that after studying Math in grade 11; I quitted it in grade 12 because of my ephemeral hatred towards the Math's teacher due to their way of imposing the mathematics so disgustingly. And because I lacked Mathematics in grade 12, I was not given admission in Bachelor's of Science in Physics here. So, as the nearest alternative to the Physics, I chose to study Geology which I was allowed to take.

Gradually, the curiosities to explore the world and find out the clue to this mysterious existence intensified so much that I devoted a whole lot of time in studying Philosophy, Religion, Physics, Mathematics, Literature, Arts, Politics, History etc. than Geology itself. The course content of the Geology never bothered me. Instead, the various Field trips and some of my kind and benevolent teachers inspired me to study Geology as comfortably as a hobby rather than taking it as a subject of a headache.

Dear colleagues, for me the entire ambience of those four years in Tri-Chandra Campus has been much more fruitful which I am realizing each day of my life. Actually, I have realized that self-inquiry is far more important and fortune giver than the college itself. The homely environment which I could have enjoyed in the prestigious universities like Harvard, Cornell, Princeton etc, I am proud that I achieved here at Tri-Chandra. Whatever I am today, it's all because of the freedom I had in those four years in the college life.

I am always thankful to Tri-Chandra for it has opened a wide horizon ahead in my life. I shall pursue a PhD degree in geology but I am not still quite sure what I am going to achieve in the future. Let that be the part of the mysteries to behold. But as a profession, I am inclined in teaching. And if there is one thing I regret sometimes, it is the opportunity which I didn't use to the fullest specifically for the Geology for all those four years. But now onwards I have sailed on my voyage in the search of the mysteries that I am constantly seeking for. Thank you for your courtesy, my friends. Missing you guys!

SCOPE OF GEOLOGY IN NEPAL

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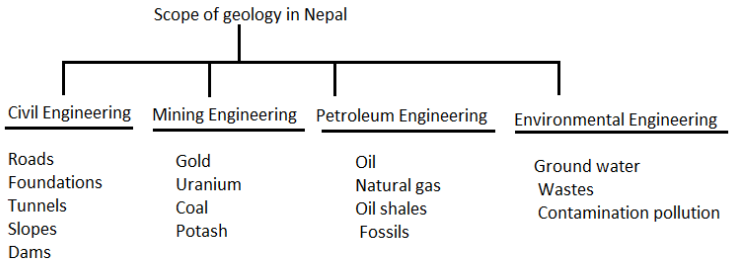
Geology comes from Greek words "Geo", which means earth and "logos", which means science. It is a branch of science dealing with the study of the earth. It is also known as earth science. The study of earth comprises of the whole earth. It is not a basic science like mathematics, physics, biology, chemistry but is an application of those basic earth sciences.

The geology of Nepal is dominated by the Himalaya—the highest, the youngest and one of the most active mountain ranges in the world. It is a product of the continent-continent collision between India and Eurasia. The Himalayan evolution is taking place even at the present. So any infrastructure, construction and development activities must be planned taking geology into account. The knowledge of geology is a must for sustainable development. Some of the most important scopes of Geology are shown in the chart below.



ConclusionGeoscientists are always curious and in the state of knowledge of the different site of geology find out a way of idea new fact and different way. It is very important in modern time for sustainable development activities at base of any construction or development work so it is important in every engineering field

Acknowledgement

I would like to express my deep gratitude to Department of Geology, Tri-Chandra Campus for providing this wonderful opportunity to write something that we have learned from our four years of geological study. Heartily thanks for all my teachers and colleagues for helping me directly and indirectly for writing this article

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I am Khomindra Bhandari born on 18 June 1994 in Baglung. I completed my SLC from New Everest Academy (2067 BC) and did my +2 from Trinity International College (2070). I used to play Taekwondo. I like playing, watching, reading, exploring new places. After completion my +2, I read a book which is written about the earth. So, this book (origin of the earth and spiritual book) inspire me to learn more about the earth. I also asked and met my senior brother and I visited Campus for the further right information. Then I joined Geology subject in Tri-Chandra Multiple Campus.

Besides studying geology, I like to study about history that seems always mysterious and about universe and astronomy that is something beyond our imagination. History is such subject that has influenced me from the school time where we used to study them in social studies. I have also gone through various papers and articles related to the history of different countries and people. The study of the universe is somehow related to geology and I am looking forward to gaining more and more information about that.

Nevertheless, I have completed my four years of geology study with memorable field trips, making really good friends and gaining lots of knowledge that has influenced me to carry my further higher study and become a successful geologist in the future.

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NEED OF GEOLOGY EDUCATION IN HIGH SCHOOL AND ITS IMPORTANCE

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Introduction

Geology can simply be defined as the study of Earth- how it worked and its 4.5 billion year history. It is derived from the Ancient Greek word Geo i.e. "Earth" and logia i.e. "study". A geologist is a person who works in the field of geology. Geologist studies some of the society's most important problems such as energy, water and mineral resources, the environment and climate changes and Natural Hazards like Landslides, volcanoes, earthquake and Flood. The study of Geology mostly focuses on rocks and soil because they assemble historical records of the planet and trace events that occurred long before human remained on our planet.

Geology has various branches where geologist works some of the major fields includes:

a) Engineering Geology

b) Geochemistry

c) Geophysics

d) Seismology

e) Environmental protection etc

Geology gives insight into the history of the earth by providing the primary evidence for plate tectonic, the evolutionary history of life and past climates. Geology is important for mineral and hydrocarbon exploration and exploitation, evaluating water resources, understanding natural hazards etc. Geology also plays a role in geotechnical engineering and is a major academic discipline.

Need of Geology in High school

Among various branches of science, geology is one of the most important subjects to learn because geology helps us to understand the environment where we are living. Geology helps us to understand more about our place. It provides information on how our earth origin, when it develops, how life came to earth, what changes occurs in past and what might of possibilities occur on the earth, etc. Geology also helps to find out the condition of our earth before millions of years ago. Geology also provides us knowledge on Natural hazards like landslides, flood, volcanoes etc, how can we deal with these kinds of natural disasters etc.

I have experienced that our school curriculum has not focused on the subject or provide any information on Geology on our books. Many of us during our high school lacked education on geology. Many of us didn't know what Geology is, what it deals with, what are the opportunities after having a geology degree, what geologist works on, etc. High school students still don't know the importance of geology as

they don't have any information on geology.

So, I believe that our education board of our country has the most weakness on this. I think education board should provide some courses on the geology so that students at least get familiar with the word geology, its importance on society for the country. If some courses are added based on the field of geology, it will be helpful for the students to understand or add some curiosity on geology. I also have experienced that many people have no any interest to study on geology because they know nothing about the geology. They have no any idea about what to do after that what's their future after that. So it's the responsibility of teachers to provide this information during their school life. High school is the best to choose the career but nobody wants their career on Geology for future because of the lacks of information toward the subject. I even wonder sometimes why our education board doesn't keep interest on the geology as it is the most important subjects to learn from our school.

I also saw some people getting more interested to study geology in BSC after Gorkha earthquake 2072. I believe they got interested on Geology because of the promotion of Geology and Geologist on social media and newspapers. After an earthquake hit Nepal, people shows some interest in geology, how earthquake generates what might be its cause its impact etc. so these things makes people curious to study geology. So what I m trying to say is that people love geology they are interested to study geology they want to know more about it but due to lack of proper information lack of concern people don't know about its importance. So school level education is the best place to start to understand the geology. So education board and government of our country have the most important responsibility toward these concerns to provide necessary information on the subject Geology.

Geology as a career and its importance

Geology can be very interesting and rewarding career. After completing the four-year college degree in geology we can start our career as a geologist. We can work on the various field on natural resources, environmental consulting companies etc. broadly speaking there's three main area of geology which is important to the people i.e. natural resources, natural hazards and engineering.

Natural resources include minerals, groundwater, fossil fuels and use of resources and disposal and management of wastes.

Natural hazard includes volcanoes, landslides, flood etc and how to mitigate the risk of these.

Engineering is about how geology affects the things we build from houses and tower blocks to bridges and tunnel.

We can even make our specific career in various fields of geology as engineering geologists, mining engineers, hydrologist, geochemist, geophysicist, etc by earning a masters degree or doctorate degree.

Employment opportunities for the geologist are very good most geologist graduates with a strong academic background and good grades have no

trouble finding jobs. So geologist can be better career options also.

Conclusion

Finally, I can say that geologists are the important organ for the development of the country as they are required in almost every field. From normal researchers to big civil sites geologist are required. Without a proper investigation on geology, the civil sites like houses, bridges, hydropower dams etc are not strong enough which in a failure results in loss of wealth and loss of human life too. So government should provide some efforts for the improvement of geology fields and helps to provide good and excellent geologist for the country.

For this, students should be prepared from the school. They should have concerns on geology and its importance from early school days.