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Research Paper

Role of Medical Geology in Indian Society

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Abstract: Medical Geology is a broad and complex subject which requires inter-disciplinary contributions from several different scientific fields. The importance of medical geology is multiple types in our society. Medical geology brings together geoscientists and medical/public health researchers to address health problems caused or exacerbated by geological materials; ultimately, it is only with multidisciplinary collaborations that interventions can be devised to reduce morbidity and mortality from such problems. Medical geology aims to understand how natural geological factors, such as, natural occurring elements (As, F, Cd, Pb, Hg, Co, Cu, Ni, U etc.) are affecting directly or indirectly Human and Animal health. Rocks are the source of most chemical elements found on the earth. Many elements in the right quantities are essential for plant, animal, and human health and have limited biological function. Generally, these elements are toxic in nature and may cause various health hazards in society. Most of these elements enter the human body via food and water in the diet and through the air that we breathe. The links between geology, environment and health are particularly important for subsistence populations that are heavily dependent on the local geology and environment for their food supply. Infectious diseases in humans are also dramatically affected by the geological environment, albeit indirectly. Geological forces shape the environments in which microbes thrive, sometimes creating opportunities for the emergence of infectious diseases as major public health problems. In the present paper an attempt has been made to describe general importance of medical geology for our society.
Keywords: Medical geology, Environment and Society.

INTRODUCTION

Medical Geology is an emerging discipline that examines links between geologic materials and processes, and the incidence spatial/temporal distributions of human and

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animal diseases. An excess or deficiency of inorganic elements originating from geological sources and/or from human activities can affect life either directly or indirectly. Sellinus et.al., (2005) define Medical geology is the science dealing with the relationship between natural geological factors and health of humans and animals and with understanding the influence of ordinary environmental factors on the geographical distribution of such health problems. It is a broad subject that requires interdisciplinary contributions from various scientific fields. Medical geology which focuses on the impacts of geology and natural environment on human and animal health can be considered as complementary to environment and medicine. The field of medical geology brings together Geologist, Medical and Public Health Researchers to deal with the health problems caused by geological materials such as rocks, minerals, water, mineral dust, and natural geologic processes such as volcanic eruptions, earthquakes and landslides.

The branch of Medical geology can also help to identify and ideally control anthropogenic sources such as contamination due to use of fertilizers, pesticides, solid wastes, and mining wastes of our environment.

OBJECTIVES

The objectives of the present research work are the study on contamination levels of groundwater and health problems in our society from the medical geological point of view. This research study will be beneficial to the health professionals, policy makers, and society for future planning.

MATERIAL AND METHOD

The literature and material were collected from various sources for discussion of rock-water interaction in giving rise to a variety of geogenic contamination of aquifers in India. Moreover, the various agro-climatic zones and physico-chemical conditions prevailing in aquifers certain processes of leaching out of contaminants from aquifer framework to the aqueous phase.

RESULT AND DISCUSSION

Health Hazard due to fluoride Contamination: Low level fluoride is required by human system as it is helpful in preventing dental carries, while consumption of high concentrations of fluoride can lead to serious health issues. The long term use of groundwater having high fluoride in excess of 1.5 mg/l results in fluorosis. The types of fluorosis are dental and skeleton type. The dental fluorosis (Fig.1) is the loss of lustre and shine of the teeth. The discoloration starts from white, yellow, brown to black. It affects both the inner and outer surfaces of the teeth. Skeleton fluorosis (Fig.2) is due to excessive quantity of fluoride deposited in the skeleton, which is more in cancellous bones compared to cortical bones. The disease is generally diagnosed at a developed stage. Fluoride poisoning leads to severe pain associated with rigidity and restricted movements of cervical and lumbar spine, knee and pelvic joints as well as shoulder joints. Crippling deformity is associated with rigidity of joints and includes Kyphosis, Scoliosis, flexion deformity of knee joints, Paraplegia and Quadriplegia. Skeletal fluorosis affects both young children as well as adults (Fig.2). The most widespread contamination in India is that of high levels of fluoride. It is widespread in different parts of India, particularly in the state of Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Gujarat, and Rajasthan, where 50-100% of the districts have drinking water sources containing excess level of fluoride. As per an estimate (FRRDF, 1999) about 66 million people in India are consuming water with fluoride level beyond the permissible limit.

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Figure 1. Showing cases of dental fluorosis.

Figure 2. Showing cases of skeleton fluorosis.

Health Hazard due to Arsenic Contamination: Human system is sensitive to arsenic. The excess arsenic in ground/surface water may cause sufficient damage to human health (Fig.3) and these may be respiratory distress due to irritation of mucous membranes, resulting into laryngitis, bronchitis or rhinitis, myocardial depolarization and cardiac arrhythmias that may lead to heart failure, gastrointestinal effects like burning lips, painful swallowing, thirst, nausea and abdominal colic. Anaemia and leucopenia are other common effects of arsenic poisoning. Ingestion of inorganic arsenic can also result in neural injury, having such symptoms like headache, lethargy, mental confusion; hallucinating, seizures and coma Skin disorders caused by long term arsenic ingestion have been commonly reported. It includes generalized hyperkeratosis, warts or corns on the palms and soles and areas of hyperpigmentation interspersed with small areas of hypopigmentation in the face, neck and back. Inorganic arsenic increases the risk of lung cancer when exposure occurs through inhalation. Ingestion of inorganic arsenic also increases the risk of skin cancer. Considering the Principal Aquifer Systems, arsenic is confined in alluvial aquifers except for a small patch in Chhattisgarh State where localized contamination is reported from gneissic aquifers. Geographically large areas affected by arsenic contamination are from West Bengal and Bihar, where the contamination has been reported from 146 blocks (89 blocks in West Bengal and 57 blocks in Bihar) distributed in 23 districts (8 districts of West Bengal and 15 districts of Bihar). Besides, arsenic affected alluvial aquifers are reported from Uttar Pradesh, and

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sporadically from Jharkhand, Haryana, Punjab, Manipur and Assam.

Figure 3. Arsenic affected persons from West Bengal and Assam.

Health Hazard due to Trace Elements Contamination

Manganese: Manganese is easily concentrated in the brain, especially in the basal ganglia, and can cause an irreversible neurological syndrome similar to Parkinson's disease. Relatively high doses of manganese affect DNA replication and causes mutations in microorganism and mammalian cells. In mammalian cells, manganese causes DNA damage and chromosome aberrations. Large amounts of manganese affect fertility in mammals and are toxic to the embryo and foetus. The risk of damage to the central nervous system is of greater importance. Manganese has got similar hydro-geochemistry. Elevated level of Mn has been reported mainly from West Bengal, Tamil Nadu, Orissa, UP and Bihar.

Uranium: In ancient times uranium was used to produce yellow glazes in ceramic. Water containing low amounts of uranium is usually safe to drink. Because of its nature, uranium is not likely to accumulate in groundwater, in fish or vegetables uranium that is absorbed and enters in human body is eliminated quickly through urine and faeces. Uranium concentrations are often higher in phosphate-rich soil, but, concentrations often do not exceed normal ranges for uncontaminated soil. Plants absorb uranium through their roots and store it there. Root vegetables such as radishes may contain higher than usual concentrations of uranium as a result. It is possible that intake of a large amount of uranium might damage the kidneys. There is also a chance of getting cancer from radioactive uranium. The provisional guideline by WHO (2004) of Uranium for drinking water is 15 µg/L. The guideline value is designated as provisional because of outstanding uncertainties regarding the toxicology and epidemiology of Uranium.

Radon: The primary adverse health effect associated with chronic exposure to radon is lung cancer other harmful respiratory effects associated with chronic exposure to radon include emphysema, pulmonary fibrosis chronic interstitial pneumonia silicosis & respiratory lesions. Radon also has the potential to generate genotoxic effects-higher incidence of chromosomal aberrations.

Strontium: The human body contains approximately 4.6 mg/kg strontium. It has no specific function, but it is absorbed because of its similar chemistry to calcium.

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Consequently, the larger part of absorbed strontium is inserted in bones. Strontium is non-toxic and a daily intake of about 0.8-5 mg is harmless, when it only contains non-radioactive strontium. The risk of radioactive strontium intake is mainly based on its carcinogenic and mutagenic mechanism, problems that occur in cell division, and possible increased infant mortality. 90Sr decays to radioactive Yttrium, which accumulates in hypophysis and ovaries, and subsequently disrupts infant hormonal development, and infant growth. The only strontium compound that is considered a danger to human health, even in small quantities, is strontium chromate. The toxic chromium that it contains mainly causes this. Strontium chromate is known to cause lung cancer, but the risks of exposure have been greatly reduced by safety procedures in companies, so that it is no longer an important health risk.

Uranium, Radon and Strontium contaminations from geogenic source have been reported in last two decades with availability of better analytical facilities. The geographical distribution of elevated level of Uranium and Radon is limited in aerial extent and confined to the States of Andhra Pradesh, Himachal Pradesh, Chhattisgarh, Madhya Pradesh, Karnataka, Rajasthan and Punjab. Their elevated concentration has got affinity to Pre-Cambrian suite of rocks and also in alluvium as the groundwater flows. Strontium has been reported from Ranga Reddy district of Andhra Pradesh.

Chromium: Water insoluble Chromium (III) compounds and Chromium metal are not considered a health hazard, while the toxicity and carcinogenic properties of Chromium (VI) have been known for a long time. Because of the specific transport mechanisms, only limited amounts of Chromium (III) enter the cells. Several *in vitro* studies indicated that high concentrations of Chromium (III) in the cell can lead to DNA damage. Acute oral toxicity ranges between 1.5 and 3.3 mg/kg. The proposed beneficial effects of Chromium (III) and the use as dietary supplements yielded some controversial results, but recent reviews suggest that moderate uptake of Chromium (III) through dietary supplements poses no risk. The acute toxicity of Chromium (VI) is due to its strong oxidation properties. After it reaches the blood stream, it damages the kidneys, the liver and blood cells through oxidation reactions. Chromium has been reported from different parts of India; however, its origin has mostly been ascribed as anthropogenic. The geogenic source has been identified related to Chromite deposits in Sukinda area of Orissa.

Selenium: There is evidence selenium can accumulate in the tissues of organisms and can then be passed up through the food chain. Usually this bio-magnification of selenium starts when animals eat a lot of plants that have been absorbing large amounts of selenium. Due to irrigation run-off concentrations of selenium tend to be very high in aquatic organisms in many areas. When animals absorb or accumulate extremely high concentrations of selenium it can cause reproductive failure and birth defects. In north western India selenium toxicity has been observed in form of snow white chlorosis in wheat and sugar cane plants and chronic selenosis in animals and human beings. The most consistent clinical manifestation indicated by animals is losing body condition and loss of hair, necrosis of the tip of the tail, reluctance to move, stiff gate, overgrowth of hoof followed by development of cracks and abnormalities in horn growth. Complaints of premature abortion have also been recorded. Exposure to Selenium in humans takes place either through food or water with typical

symptoms like loss of finger toe nails and hair and progressive deterioration of health. Majority of the population complained of nausea, headache and also exhibited tooth decay, staining of teeth and nails with brittleness and longitudinal streaks. Selenium in groundwater is highly localized in distribution and has been reported as patches in Himachal Pradesh and Punjab, affecting the Alluvium and a variety of sedimentary and igneous rock types.

Conclusion: The interdisciplinary field of "Medical Geology" has occurred from the need to understand the relationships between human health and our surrounding environment, both natural and anthropogenic. It deals with the links between geology and associated health problems in human health. Most research focuses on in developing countries where a direct relationship between the geology and element intake is observed (e.g. As rich drinking water in west Bagal and Chhatishgarh, fluoride contamination in deferent states of India). Numerous of studies have also examined health issues in India due to trace elemental concentration in groundwater. IGCP project 454 has made great progress in advancing the field of Medical Geology through numerous studies on groundwater/surface water contamination India. Though at present, human health problems related to the abnormal concentration of toxic elements in water, soils and sediments have been reported in a limited way, their exact inter-relationship needs to be systematically established. The awareness of certain diseases of human life related to toxicity by As, F and Trace element requires a coordinated approach between medical geology and society. Though the main objective is identify new problems on human health issues in our society of anomalies of As, F, and trace elements which may prove hazardous for human health. The medical geology will help to identify and prevalent health problems of Natural diseases of our society. A coordinated effort by geoscientists and medical scientists can lead to the identification of the causative factors for health hazards and their geological locales. This can then help in mitigating the health hazards by scientific use of preventive measures, biogenetic and chemical treatments and any other modern techniques. The remedial measures includes variety of options, ranging from removing the toxic elements from groundwater/surface water after it is extracted, searching alternative aquifers, reducing the concentration level within the aquifer itself, dilution of the contaminants by artificial recharge of groundwater.

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