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ES408 Medical Geology
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Submitted to:

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This article discusses an overview of Medical geology and how it can be used to better understand the relationships between human health and our surrounding environment. According to the article “Medical geology is defined as the science dealing with the relationship between geological factors and health problems in humans, animals and plants (cf. Selinus 2002; Finkelman et al. 2001)”. Medical geology specifically looks at geographical distribution of disease and examining the causal associations between specific diseases and the physical and social environments.

Medical geology has been dated in countries by ancient philosophers and physicians in Greece and China. Hippocrates is considered by scientists to be the founder of medical geology. He found that environmental factors affected the distribution of disease. The Chinese medical texts have also had records of medical geology dating back to the 3rd century B.C. In one of these documents they had found a relationship between lung problems related to rock crushing and symptoms of occupational Pb poisoning. Medical geology has also been used in the field of archaeology. Archaeologists have analyzed elements in bone material can provide an excellent tool to study the diet and nutritional status of the past humans and animals.

There are two primary branches that medical geology can be split into. The first branch strictly relates to the natural occurrence of elements in the geologic environment such as the ingestion of food grown in soils with either element deficiencies or toxicities. The other branch relates to elemental occurrence relative to natural hazards examples such as earthquakes, volcanic eruptions, flooding and landslides. The geology of an area can have
a direct impact on the regional input of elements into the soil, air and water. The article gives examples of elements such as Arsenic that can be found in water all over the world but is a serious problem in Bengal Basin, India where Arsenic levels in the drinking water are at elevated and potentially dangerous levels, Molybdenum found in soil can be hazardous to livestock the elevated levels of Mo are unable to absorb Cu which can then lead to growth or reproductive problems, and Radon a gas as a result from a decay of uranium that can easily move through soil and could leak into cracks through houses and drains which could lead to potential health risks and lung cancer.

Heavy metals are able to pass through living tissue are addressed in the article by pathways, intake, uptake and excretion. Intake specifically pertains to inhalation, ingestion or dermal absorption. Ingestion is the more common route of exposure.


In this article medical geology is defined as a science that deals with the impacts of geologic materials and processes on animal and human health. It also states that medical geology is not strictly an emerging discipline but rather a re-emerging discipline due to the fact that the relationship between geologic materials and human health has been known for centuries.

Selenium is an essential trace element having antioxidant protective functions as well redox and thyroid hormone regulation properties. Selenium deficiency due to soils low in selenium have shown to cause severe physiological impairment and organ damage such as juvenile cardiomyopathy and muscular abnormalities in adults. Picture below shows an
example of selenium deficiency.


Rocks are the fundamental building blocks of the planet surface with the 92 naturally occurring chemical elements many essential to living things such as plants, animals and humans. These elements can be taken in through food, water and even the air.

<table>
<thead>
<tr>
<th>Element</th>
<th>Earth's crust</th>
<th>Ultrabasic</th>
<th>Basalt</th>
<th>Granite</th>
<th>Shale</th>
<th>Limestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>As</td>
<td>1.8</td>
<td>1</td>
<td>2</td>
<td>1.5</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Cd</td>
<td>0.2</td>
<td>-</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Co</td>
<td>25</td>
<td>150</td>
<td>50</td>
<td>1</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>Cr</td>
<td>100</td>
<td>2,000</td>
<td>200</td>
<td>4</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>Cu</td>
<td>55</td>
<td>10</td>
<td>100</td>
<td>10</td>
<td>50</td>
<td>15</td>
</tr>
<tr>
<td>Pb</td>
<td>12.5</td>
<td>0.1</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Se</td>
<td>0.05</td>
<td>-</td>
<td>0.05</td>
<td>0.05</td>
<td>0.6</td>
<td>0.08</td>
</tr>
<tr>
<td>U</td>
<td>2.7</td>
<td>0.001</td>
<td>0.6</td>
<td>4.8</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>W</td>
<td>1.5</td>
<td>0.5</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Zn</td>
<td>70</td>
<td>50</td>
<td>100</td>
<td>40</td>
<td>100</td>
<td>25</td>
</tr>
</tbody>
</table>

Elements need to be monitored closely in the body too much or too little can cause potential health risks.
<table>
<thead>
<tr>
<th>Element</th>
<th>Deficiency</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>Anaemia</td>
<td>Haemochromatosis</td>
</tr>
<tr>
<td>Copper</td>
<td>Anaemia</td>
<td>Chronic copper poisoning</td>
</tr>
<tr>
<td></td>
<td>&quot;Sway back&quot;</td>
<td>Wilson-, Bedlington-disease</td>
</tr>
<tr>
<td>Zinc</td>
<td>Dwarf growth</td>
<td>Metallic fever</td>
</tr>
<tr>
<td></td>
<td>Retarded development of genitals</td>
<td>Diarrhoea</td>
</tr>
<tr>
<td></td>
<td>Akrodermatitis enteropathica</td>
<td></td>
</tr>
<tr>
<td>Cobalt</td>
<td>Anaemia</td>
<td>Heart failure</td>
</tr>
<tr>
<td></td>
<td>&quot;White liver disease&quot;</td>
<td>Polycythaemia</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Dysfunction of genitals</td>
<td>Ataxia</td>
</tr>
<tr>
<td></td>
<td>Convulsions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malformations of the skeleton</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urolithias</td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td>Disturbances in the glucose metabolism</td>
<td>Kidney damage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Nephritis)</td>
</tr>
<tr>
<td>Selenium</td>
<td>Liver necrosis</td>
<td>&quot;Alkal disease&quot;</td>
</tr>
<tr>
<td></td>
<td>Muscular dystrophy (&quot;White muscle disease&quot;)</td>
<td>&quot;Blind staggers&quot;</td>
</tr>
</tbody>
</table>
Aggregation of external factors in relation to organisms defined as the environment life. Two important components of this environment: Parts of the planet Earth on which real conditions exist for maintenance of life in any form; Natural conditions that can exert influence on the living world.

Natural environment at the level of human life is made up of five components: atmosphere, hydrosphere, lithosphere, animal life, and plant life. Three planetary functions of the natural environment play a special role in the life of man and his environment: biological productivity (provides forms of life with food products), Maintenance of the optimal regime and balance of the earth’s aqueous envelop and gas composition of the atmosphere, and natural biological self-purification.

Handbook of medical geography classifies the factors of the natural environment. Dynamic equilibrium is created from interaction of solid rocks, loose soil, groundwater, natural gases and microorganisms.

USEFUL PROPERTIES OF THE GEOLOGICAL ENVIRONMENT

Two main categories: Ones inherent in the geological environment in narrow sense. Or geological ambient and properties associated with geological wealth. Geological ambient is utilized by the whole living world, and its useful properties (the esthetic and sensual ambient, shelters and obstacles, and the fertile pedological ambient. Geological wealth refers to that part of the geological environment with its useful properties that can be separated, transported, and then utilized, whether in unmodified form or after certain transformations. Geological wealth includes not only mineral raw materials, but also other mineral substances that are utilized without additional processing. Harmful substances in the geological environment consists of medium- heavy and heavy elements of the Mendeleyev periodic system.

CHARACTERISTICS OF GEOLOGICAL FACTORS AND THEIR INFLUENCE ON HUMAN HEALTH.

In the manual “The Ecology of Human Disease” according to J. May a disease can arise only where factors of two kinds coincide at a certain point in time and space: first factors that take the form of an environmental stimulus and secondly factors that provoke a reaction of tissue in response. Inorganic stimuli may include heat, humidity, the regimes of wind and light, and trace elements in soil, food, and water. Radiation, magnetic fields, cosmic rays, and static electricity have been inadequately studied.

ROLE OF ELEMENTS IN NUTRITION OF ANIMALS AND HUMANS
Nutrition of animals and man must be studied within the framework of a system that includes rocks, water, soil, air, plants, animals, and man. Overall relations of the systems enable us to model many vital processes, which should ensure a long and healthy life.

Macro and microelements are needed for mineralization of growing tissues, formation of the fetus in pregnant females, egg formation in egg-laying hens, wool growth in sheep, hair growth in different domestic animals and renewal of tissues. Basic functions of microelements are very diverse and numerous, depending on the element.

Macroelements (Ca, Mg, Na, Cl, K, P, and S), Microbioelements (Mn, Fe, Co, Cu, Zn, Se, Mo, I and F)

Other microelements (Si, V, Cr, Ni, As, Sr, Cd, Sn, Hg, Pb, and Ta)

HUMAN PHYSIOLOGICAL PROCESSES

Earth materials exposed through respiration, ingestions and dermal. Respiratory system has a series of built-in defenses, natural mechanisms and strategies that are very effective for minimizing inadvertent transport of a wide range of potential hazards such as the nose where hairs, and or sneeze will expel unwanted materials.

In the article written by Edmunds and Smedley discusses elements found in groundwater and the potential health risks and benefits. Both advanced and developing countries strive for safe drinking water and waster of acceptable quality.

According to the article all natural waters contain traces of chemical elements but is mostly unquantifiable concentrations. Surface and shallow ground waters closely reflect the geology.

Elements and environmental issues can cause changes to waters such as water hardness and acid water. Elemental deficiencies related to geology such as Selenium may include muscular degeneration, impeded growth, fertility disorders anemia and liver disease. Iodine deficiency has been associated with goitre.

Other elements such as lead are known as a cumulative poison and symptoms may show initiating tiredness irritability, anaemia, and behavioral changes. Cadmium an acute produces symptoms like giddiness, vomiting, respiratory difficulties, cramps and loss of consciousness at high doses.

Health relates not only to excess of trace elements in drinking water supplies, but may also relate to deficiencies. Water is not their only dietary source and often relationships may be masked by the effects of other elements.


In this article an element is essential if it is present in living tissues at a relatively constant concentration, it provokes similar structural and physiology anomalies in several species when removed from the organism, these anomalies are prevented or cured by supplementation of the element, WHO refers to an element as an essential to an organism when reduction of its exposure below a certain limit results consistently in a reduction in a physiologically important function, or when the element is an integral part of an organic structure performing a vital function in the organism.” Concept of essentiality is that it is necessary to supply an organism with adequate amounts of the concerned elements.

The article speaks of eleven abundant elements in the biological systems and these include hydrogen, oxygen, carbon, nitrogen, sodium, potassium, calcium, magnesium, phosphorus, sulfur and chlorine.
The above tables show the elements and how much would be in the human body.

The human body is 71% water with an abundance of hydrogen and oxygen. Water helps the body serve as a lubricant and forms the base for saliva and the fluids that surround the joints it also helps by regulating the body temperature and alleviate constipation by moving food through the intestinal tract and contributes to high oxygen in the body.


This brief article discusses drinking what. What the purpose of water is such as serves the carrier for a variety of substances both beneficial and harmful and how it may be metabolically transformed in the water.

Health benefits of waterborne earth materials such as calcium, magnesium, and fluorid e can be found naturally or can also be added as supplements. Health hazards of waterborne earth materials can contain Arsenic, Mercury, Selenium and molybdenum, Radium and Radon, and microbes.

Research is still continued to in order to be able to predict potential adverse health effects will provide the basis for development of effective prevention or mitigation measures to either the water source or the human response.

I. Introduction
   a. The provision of safe drinking water as well as water of acceptable quality remain prime targets for both advanced and developing countries.

II. Essential and non-essential elements
   a. All natural waters contain traces of most of the chemical elements but more often at extremely low or unquantifiable concentrations. Nine major species HCO₃, Na, Ca, SO₄, Cl, NO₃, Mg, K, and Si make up over 99% of the solute content of natural waters with a pH of 7.

III. Geochemical baseline conditions
   a. Surface and shallow ground waters will closely reflect the geology
   b. Reactions between rainwater and bedrock over a timescale of days or months during percolation, followed by emergence as springs or as inputs to the water table, give the ground water its essential mineral character.

IV. Natural Water hardness
   a. Water hardness
      i. Water hardness-It has long been suspected that a casual link exists between water hardness and cardiovascular disease (Gardner 1976; NAS 1977; Masironi 1979)
      ii. British committee on Medical Aspects of Food Policy (COMA 1994) found a weak inverse relationship between water hardness and cardiovascular disease mortality, but noted that the size of the effect was small and most clearly seen at water hardness levels below 170mg1⁻¹
   b. Acid water and mobilization of toxic metals
      i. Acid groundwater results from natural processes such as flow through non-carbonate rocks from pyrite oxidation or from pollution (acid rain)
      ii. Common in Africa, Asia and South America
   c. Aluminum
      i. Major element in alumino-silicate minerals and is therefore a common constituent of most rocks.
      ii. Occurrence of high Al in drinking water has been linked to the development of Alzheimer’s disease (e.g. Martyn et al. 1989)
   d. Beryllium
      i. Toxic at industrial exposure levels (Griffits et al. 1977)
ii. Limited data have been reported on its occurrence and toxicity in natural waters and elsewhere.

V. Redox-related controls
   a. Nitrate
      i. Links to methaemoglobinaemia and stomach cancers.
      ii. Excessive nitrate concentrations are related mainly to pollution and have been comprehensively reviewed elsewhere (Foster et al. 1982; Chilton et al. 1994)
   b. Iron and manganese
      i. Manganese essential and readily absorbed.
      ii. Water with high Mn and/or Fe concentrations is usually unpalatable in terms of taste, odor, staining of laundry and discoloration of food (Gale & Smedley 1989)
   c. Arsenic
      i. Toxic and carcinogenic
      ii. Hyperpigmentation, depigmentation, keratosis and peripheral vascular disorders are the most commonly reported symptoms of chronic arsenic exposure (Matisoff et al. 1982; Chen et al. 1994; Morton & Dunette 1994)

VI. Element deficiencies related to geology
   a. Water health related problems are created by element deficiencies. Such diseases are most apparent in rural communities where water and food are locally derived and little exotic produce is consumed.
   b. Selenium
      i. Essential in diets of humans and animals
      ii. Deficiency may promote a health problem. Symptoms include muscular degeneration, impeded growth, fertility disorders, anemia and liver disease (Lag 1984; Peereboom 1985)
      iii. High concentrations >10mg or greater may cause skin discoloration and tooth decay.
      iv. Few studies of Se in drinking water in developing countries have been carried out.
   c. Iodine
      i. Deficiency long been associated with endemic goitre. Goitre results from enlargement of the thyroid.
      ii. Iodine is chalcophile and may be found in higher concentrations with organic carbon (e.g. Fuge & Johnson 1986)
      iii. Readily adsorbed onto Fe and Al oxides (Whitehead 1984)

VII. Mineral-saturation control
   a. Health-related problems usually emerge when abnormally low concentrations of associated ions allow the concentrations of the harmful element increase. Increases can be predicted from and described by the relevant solubility product (K₅)
   b. Fluorine
      i. Common trace element recognized in many parts of the world.
ii. High concentrations in water have been linked with cancer (Marshall 1990)

c. Barium
i. Minor element in many rock types but abundant in acid igneous rocks
ii. Readily released during water-rock interaction but solubility is controlled by solubility of barite.
iii. Barium has possible association with cardiovascular disease (Brenniman et al. 1981; WHO 1993)

VIII. Other elements
a. Lead
i. Major element in galena (PbS) and a common constituent in hydrothermal mineral veins.
ii. Pb also produced from smelting, motor-vehicle exhaust fumes and from corrosion of lead pipework.
iii. Lead is a cumulative poison, initiating tiredness irritability, anaemia, behavioural changes and impairment of intellectual functions in affected patients (Tebbutt 1983)

b. Cadmium
i. Cadmium occurrence in the environment is from both natural and human resources
ii. Usually associated with zinc ores and may be present in volcanic emission and released from vegetation (Robards & Worsfold 1991)
iii. Cadmium is an acute toxin, producing symptoms such as giddiness, vomiting, respiratory difficulties, cramps and loss of consciousness at high doses.
iv. Chronic exposure can lead to anaemia, anosmia (loss of sense of smell), cardiovascular diseases, renal problems and hypertension (Mielke et al. 1991, Robards & Worsford 1991)
v. Exposure of humans to Cd is likely to be greatest from food intake and inhalation. Drinking water should have lower Cd concentrations unless water sources are affected by volcanic exhalations, landfill leachate, or mine waters.

IX. Conclusions
a. Not all elements relevant to human health have been considered in detail in this paper.
b. Potential harmful dissolved constituents in some groundwater’s include U, Sb, Th, CN, Hg, Ni, and Cr.
c. Health relates not only to excess of trace elements in drinking water supplies, but may also relate to deficiencies.
d. Relationships between trace elements in water and health are complex. Water is not their only dietary source and often relationships may be masked by the effects of other elements.
I. Essentiality of Elements
   a. Element is essential if
      i. It is present in living tissues at a relatively constant concentration
      ii. It provokes similar structural and physiological anomalies in several species when removed from the organism
      iii. These anomalies are prevented or cured by supplementation of the element.
      iv. According to WHO “An element is considered essential to an organism when reduction of its exposure below a certain limit results consistently in a reduction in a physiologically important function, or when the element is an integral part of an organic structure performing a vital function in the organism.”
      v. Concept of essentiality is that it is necessary to supply an organism with adequate amounts of the concerned elements.

II. Major, Minor, and Trace Elements, in Biology
   a. Eleven elements abundant in biological systems: Hydrogen, oxygen, carbon, nitrogen, sodium, potassium, calcium, magnesium, phosphorus, sulfur, and chlorine
   b. Same elements compromise 99.9% of atoms.
   c. 90 naturally occurring elements in the periodic table. 73 are trace elements. Of the 73 18 are essential or possible essential trace elements: lithium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, tungsten, molybdenum silicon, selenium, fluorine, iodine, arsenic, bromine, and tin.

III. Brief Description of the Function of Major Elements
   a. Human body roughly 71% water with abundance of hydrogen and oxygen
   b. Humans need water to survive. Cell and Organ functions depend on water. Water serves as a lubricant and forms the base for saliva and the fluids that surround the joints.
c. Water regulates body temp, alleviate constipation by moving food through the intestinal tract and contributes to high oxygen in the body.
d. A FEW IMPORTANT POINTS ABOUT HYDROGEN 
   i. Hydrogen appears in three states (cation, a covalently bound state, and anion)
   ii. Can take part in one-or two electron processes.
e. CARBON: THE BACKBONE OF ORGANIC CHEMISTRY AND BIOCHEMISTRY 
   i. Carbon atom capable of combining with up to four other atoms. These are covalent bonds.
   ii. The atomic number of carbon is six; two in the K shell and four in the L shell.
   iii. Versatile atom
   iv. Organic compounds in biology represented by carbohydrates, lipids, proteins, and nucleic acids.
f. CARBOHYDRATES 
   i. Carbon, hydrogen, and oxygen make up most of carbohydrates
   ii. Carbohydrates provide short-term energy storage (monosaccharide’s), long-term energy storage (starches and glycogen) and structural support (cellulose found in all plant cell walls.
   iii. Important components of DNA and RNA

g. LIPIDS 
   i. Lipids are insoluble in polar solvents such as water. They dissolve in nonpolar solvents and they are nonpolar.
   ii. Energy storage molecules as insulation and protection for internal organs as lubricants and as hormones.
   iii. Phospholipids are major structural elements of membranes.
h. PROTIENS 
   i. Maintains and drives the reactions of cells
   ii. Acts in supportive tissue like cartilage and involved in muscle movement.
   iii. Many proteins are enzymes
i. Nucleic Acids 
   i. DNA and RNA are nucleotides
   ii. Chain of nucleotides is a polymer forming a nucleic acid
j. OXYGEN THE SAVIOR AND REACTIONIST 
   i. Humans and other animals need oxygen
   ii. Hemoglobin transports oxygen in mammals, hemerythrin in some marine invertebrates and hemocyanin in snails
   iii. Involved in ATP

IV. Brief Description of the Functions of Minor Elements 
   a. Minor elements compromised of sodium, magnesium, phosphorus, sulfur, chlorine, potassium, and calcium.
   b. SODIUM, POTASSIUM, CHLORINE: INTERACTIONS AND ION PROPERTIES
i. Biological functions of Sodium, Potassium, and Chloride
   1. K, Na, and Cl control of the following properties in all cells
      of all organisms: Osmotic pressure, Membrane potentials,
      Condensation of polyelectrolytes, required ionic strength
      for activity
   2. Na vitamin transport especially vitamin C.

ii. MAGANESIUM AND PHOSPHATE CLOSE CONNECTIONS
   1. Magnesium homogeneously distributed in organisms.
      a. Hormonal Regulation of Magnesium Homeostasis
         i. Mechanism behind hormonal regulation
            seems to be hormones or agents acting on
            the production of cyclic AMP.
      b. Magnesium and Nucleic Acid biochemistry
         i. Role of Mg is to neutralize negative charges
            from phosphates, either electrostatically or
            by forming hydrogen bonding networks
            from waters of solvation.
      c. Magnesium and Photosynthesis
         i. Organisms capable of photosynthesis
            include certain bacteria, cyanobacteria,
            algae, nonvascular plants, and vascular
            plants.
         ii. Photosynthesis is the source of the Earth’s
             molecular oxygen.
         iii. Photosynthesis takes place in chloroplasts
      d. Calcium Messenger and Support
         i. Calcium has many functions in biology
         ii. Triggers new life at fertilization, controls
             several developmental process, and cellular
             processes as metabolism, proliferation,
             secretion, contraction, learning and memory
             (Jaiswal, 2001)
         iii. Known function of calcium its an integral
             component of bone and teeth phosphates
         iv. Calcium contained in the skeleton as more
             or less crystalline calcium phosphate (bone
             apatite)
e. **CALCIUM HOMEOSTASIS**

i. Calcium in the GI tract originates from the diet and also from secretions.

ii. PTH key regulatory hormone of calcium metabolism whose secretion is stimulated by low plasma Ca concentrations and by low plasma magnesium concentrations

iii. The main effect of PTH is to raise plasma Ca concentrations through actions on bones, the kidney, and indirectly the GI tract.

f. **Calcium Signaling**

i. Plays an important role in cellular signaling

V. **The Functional Value of Trace Elements**

a. **VANADIUM, COBALT, AND NICKEL ARE NOT USED EXTENSIVELY**

i. Can be found in the transition metal area in the periodic table are suspected to have biological functions
b. CHROMIUM, MOLYBDENUM, AND TUNGSTEN
   i. Comprises group 6 in the periodic table
   ii. Trace elements of group 6 often appear covalently bonded and not as simple as metal ions

c. MANGANESE: PHOTOSYNTHESIS AND DEFENSE AGAINST OXYGEN
   i. Manganese found only in trace amounts in living organisms

d. IRON: SAVIOR AND THREAT
   i. Iron is the most important metal of all metals and is the fourth most abundant element in the Earth’s crust.
   ii. Iron containing proteins carry out oxygen transport and storage, electron transfer, and substrate oxidation-reduction. Four major classes of protein carry out these reactions (Beard, 2001) in mammalian systems: Iron containing, nonenzymatic proteins, iron sulfur enzymes, heme-containing enzymes, iron-containing enzymes that are non-iron sulfur, non-heme enzymes


WHAT WE DRINK:
Drinking water provides necessary hydration and serves as the carrier for a variety of substances, both beneficial and harmful, that enter and may be metabolically transformed by the body.
3% is fresh water
This chapter will be limited to a description of the constituents in drinking water as potential benefits to public health (Fluoride) and as potential hazards to public health (e.g. microbial contamination or dissolved toxic elements).

Drinking water contains a variety of substances that result from interactions with geological materials or from other sources. These include metals, major and trace elements, natural and anthropogenic organic substances, and microorganisms.

HEALTH BENEFITS OF WATERBORNE EARTH MATERIALS
Some beneficial elements, such as calcium, magnesium, and fluoride either occur naturally in water at sufficiently high concentration to positively influence human health or can be added to water as supplements.

i. CALCIUM AND MAGNESIUM (HARD WATER)
   1. Ca and Mg are two of the three most abundant cations in natural waters.
   2. Water hardness is combined measure of Ca and Mg in the water.
   3. Ca good for osteoporosis.

ii. Fluoride
   1. As it occurs in drinking water has two beneficial effects helps prevent dental caries, and it contributes to bone mineralization and bone matrix integrity (ADA, 2005).
   2. Excess fluoride may cause fluorosis (a condition that results in striations in tooth enamel).

HEALTH HAZARDS OF WATERBORNE EARTH MATERIALS
Health hazards from drinking water arise from natural or anthropogenic contamination of source waters used for potable use.
Two components to the risk of pollution from groundwater—groundwater vulnerability and contaminant load.

i. Arsenic
   1. Metalloid element found ubiquitously in nature, occurring in rocks and soil, coal, volcanic emissions, undersea hydrothermal vents, hot springs and extraterrestrial material.
   2. Water exposure most common source of exposure to environmental arsenic.

ii. Mercury
   1. Most widely known pollutants. Natural phenomena such as erosion of mineral deposits and volcanoes and human activities such as metal smelting, coal fired electricity generation, chemical synthesis and use and waste disposal.
   2. Three main forms elemental mercury, inorganic mercury and organic methyl, ethyl and phenylmercury.
   3. Major route of toxicity is through consumption of contaminated fish.

iii. SELENIUM AND MOLYBDENUM
   1. Frequently occur together in soils and these trace elements can be concentrated by agricultural practices
   2.
iv. RADIUM AND RADON
   1. Occur naturally in groundwater originating from geological sources or are present in surface water as the result of contamination from a range of sources that include weapons testing, nuclear power plants, landfills, and medical applications.

v. MICROBES
   1. Microbial pathogens include bacteria, viruses, and protozoan parasites. Bacteria are common infectious agents implicated in many waterborne disease outbreaks
   2. Many routes of exposure including consumption of drinking water, and food crops grown in soil irrigated with wastewater or fertilized sludge and contact with contaminated recreational water.
   3. Norwalk virus most widespread human calicivirus causes outbreaks of waterborne and foodborne viral gastroenteritis.

PHARMACEUTICAL SUBSTANCES
i. Endocrine disrupting compounding-Chemicals that modify the function of endocrine glands and their organs (NRC, 1999b; Arnol et al., 2006;)

   **BOX 4.2**
   **Endocrine Disrupting Compounds**

   Endocrine disrupting compounds (EDCs) have a number of characteristics:

   - EDCs interfere with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis (normal cell metabolism), reproduction, development, and/or behavior.
   - EDCs can be hormone mimics, with hormone-like structures and activities. That is, EDCs sometimes have chemical properties similar to hormones and bind to hormone-specific receptors in or on the cells of target organs.
   - EDCs frequently have lower potency than the hormones they mimic (i.e., require a higher dose to elicit an equivalent response) but may be present in water at high concentrations relative to natural hormones. Furthermore, EDCs may not be subject to normal (internal) regulation mechanisms.

OPPORTUNITIES FOR RESEARCH COLLABORATION
ii. Overall goal in all cases is to be able to predict potential health effects based on improved process-based understanding and, where appropriate, through modeling.

iii. Prediction of potential adverse health effects will provide the basis for development of effective prevention or mitigation measures to either the water source or the human health response.
iv. High priority collaborative research activities are to:

1. Determine the health effects associated with water quality changes induced by technologies and other strategies currently being implemented, or planned, for extending groundwater and surface water supplies to meet increasing demands for water by a growing world population.

2. Identify and quantify the health risks posed by “emerging” contaminants, including newly discovered pathogens and pharmaceutical chemicals.

In this article Komatina makes us aware of anthropogenic factors and what the possible outcomes if these factors are not addressed. According to Keller, Shchepin, and Chalkin (1993) three interrelated tasks are pressing today: Protection of the natural environment from further pollution, protection of human health from adverse effects of environmental contamination and renewal and healing of the damaged environment.

Human activity has been changing the Earth’s surface but has also made changes in the upper part of the Earth’s crust that in scale and consequences can be compared with geological process.

The article also discusses water pollution, the pollution of agricultural soil, air pollution, and radioactive pollution. All of these can greatly effect the human health by polluting foods that we eat, the water we consume, the air we breathe and even just exposure to certain elements.

If we do not address these concerns this can pose a real threat to the survival of living organisms.


This article discusses the topic of how geological environments can affect the human health. Non-infectious somatic diseases such as heart disease and cerebrovascular disturbances are common in developed countries. Leading risk factors include the ingestion of cholesterol and other animal fats, high consumption of kitchen salt, obesity and hereditary factors (hypertension), and increased consumption of sugar and fats. Malignant tumors and infectious and parasitic diseases are also common in these areas.

According to Komatina, 2004 “Strictly localized diseases remained for a long time in the shadow of rare diseases in the wider sense.“ For specialists in the area of geographic pathology and especially medical geology these rare and strictly localized diseases are important because there is hope of linking their incidence or characteristics with some factor of the geographic or geological environment. Examples given of rare and strictly
localized Endemic diseases are Kashin-Beck disease, Kuru sickness, Vilyui encephalitis and Buruli pustules.


Plant (et al 2003) talks about how recent population growth and economic development are contributing to problems such as land degradation, pollution, urbanization, and the effects of climate change over large areas of the earth’s surface, giving increasing cause for concern about the state of environment.

Essential and potentially harmful chemical elements, radioactive substances and persistent organic pollutants are three groups that are identified as concerns pertaining to Earth’s life support system. K, Na, Ca, P, Cl, S, and N are elements that important to animal life.

Plant had concluded that with a multi-determined global geochemical database would make a major contribution to understanding and hence improve environmental quality worldwide.

Weinstein and Cook, 2007, Epidemiological Transitions and the Changing Face of Medical Geology, Ambio, v. 36, no. 1

Weinstein and Cook 2007 article entitled “Epidemiological Transitions and the Changing Face of Medical Geology” talks about before, the first, second and third epidemiological transitions.

Hunter/gatherers before the epidemiological transitions major determinant of the disease was resource death. Leading to lack of tools, shelter, food and healthy mates. During the farmers and the first epidemiological transition the population size and density increased setting the scene for infectious disease to take over as the major contributor to the human disease burden. During the industrial societies and the second epidemiological transition there was an improvement in population health indicators associated with development. The third epidemiological transition is described as the changes in disease burden associated with the disruption of health-sustaining ecosystem services.

Weinstein and Cook concluded that in article medical geologists of the future will be a multidisciplinary field and will be able to span through geological, medical and political sciences.
ANTHROPOGENIC FACTORS

I. Today we face the problem of preventing a genetic catastrophe. According to Keller, Shchepin, and Chalkin (1993) three interrelated tasks are without doubt very pressing today: 1) Protection of the natural environment from further pollution 2) Protection of human health from adverse effects of environmental contamination and 3) renewal and healing of the damaged environment

II. Geological factors unquestionably play an important role through their defense mechanisms and ability to dictate both the process of pollution and effective measures for sanation of the environment.

PROCESSES OF POLLUTION AND DESTRUCTION OF THE GEOLOGICAL ENVIRONMENT

I. Anthropogenic distribution of substances of the lithosphere, hydrosphere, and atmosphere has had increasingly negative consequences.

II. M. Babovic (1992) changes associated with destruction, transport, accumulation, and lithification can be distinguished.

III. Anthropogenic activity represents an increasingly important factor in the inception and development of landslides and other exogenous geological processes.

IV. Human activity not only alters the appearance of the Earth’s surface, but also causes significant changes in the upper part of the Earth’s crust that in scale and consequences can be compared with geological processes.

ARTIFICIAL PHYSICAL FIELDS-RISKS AND POSITIVE INFLUENCE

I. ARTIFICIAL (ANTHROPOGENIC) ELECTROMAGNETIC FIELDS
   a. Artificial fields have greater coherence, a higher level of energy, and more stable frequency and duration. They have a stronger influence on the biosphere
b. Associated with Electrostatic fields: ert negative, positive, or neutral influence on the organism. And also associated with Long-distance power lines. The phenomenon of so called “electromagnetic smog” occurs here.

II. ARTIFICIAL MAGNETIC FIELDS
a. Created by industrial activity. Passes easily through house walls, almost all metals, and tissues of the human body.

b. N. Trifunovic (1998) malignant diseases, myocardial infarct, and cerebral accidents are caused in part by anomalous increase of the magnetic-electromagnetic field (the sum of the Earth’s natural magnetic field and the artificial field consisting of induced and remnant magnetizations) in living and working space.

III. Artificial ionizing radiation
a. Causes erythema of the skin and dermatitis, atrophy of skin glands, hyperkeratosis and tumors (Dj. Sofrenovic, 1993)

IV. Artificial non-ionizing radiation
a. Arises from different technological sources (B. Vulevic, 2000)

b. UV radiation emitted by lamps with inert gases and hydrogen lamps, halogen and fluorescent lamps, and lasers.

c. Infrared radiation is emitted by hot and red-hot sources (industrial furnaces, apparatuses for gas welding, heaters, burner rooms), sources with electric discharge (arc lamps and arc-welding equipment), and lasers.

V. ARTIFICIAL SEISMIC FIELDS
a. Formed as a result of chemical and nuclear explosions, mining activity, and seismic research.

b. Artificial earthquakes are known to have been induced by construction of hydroelectric structures, major chemical accidents, nuclear explosions, mining activity, or seismic research.

POLLUTION OF AGRICULTURAL SOIL
a. Due to the presence of humans and clays, oil can bind very high concentrations of harmful materials or elements.

b. High intensity food production requires that plants be protected from a number of pests, diseases and weeds. Agricultural soil is today almost unthinkable without the use of pesticides.

c. Fertilizers applied to agricultural soil contain four harmful ingredients: Nitrogen compounds (nitrates, nitrites, ammonia, and organic nitrogen), sulfates, chlorides, and phosphates.

WATER POLLUTION
a. Pollution of water-Under the influence of chemical components, heat, or bacteria to an extent that it unfavorably affects (without necessarily creating a
threat to human health) water use in everyday life, for agricultural and communal purposes, and in industry.

b. Main pollutants are industrial wastewater and communal sewage; pollutants linked with agriculture; ones arising in mining regions; and petroleum and petroleum products.

c. Biodegradable pollution undergoes intensive processes of biological decomposition, the strongest action here being exerted by microorganisms. Bioresistant pollution in principle presents less of a problem if it is biologically inactive, inert inorganic material forming sludge that is a suitable environment for creation of benthos and development of biological processes in it. Toxic pollution of inorganic (heavy metals) or organic (pesticides, etc) nature represents the most harmful kind of bioresistant pollution.

d. Chemical polluting substances are divided into ones that are toxic, carcinogenic, teratogenic and mutagenic.

AIR POLLUTION

a. Metallurgy problems have arisen in the area of air hygiene.

b. Automobile traffic contributes to air pollution

c. Radioactive air pollution

ARTIFICIAL RADIOACTIVE POLLUTION

a. First diseases that we know of caused by radioactive radiation were lung diseases

b. “Modern atomic era” Nuclear weapons, various nuclear installations, radioactive isotopes, nuclear machines in labs and clinics and along with them radiation accidents of greater and smaller dimensions that have increasingly affected man, animals and plants.

c. Artificial (fabricated) radionuclides enter the biosphere three ways

   a. As a consequence of radioactive fallout after experimental nuclear explosions

   b. Through escape of radioactive substances due to breakdown of nuclear reactors or other nuclear installations

   c. Due to use of radioactive isotopes for medical, technological, and other purposes.

   d. Radioactive fallout must be considered the most significant form of contamination of the biosphere.
POLLUTION AND DISTURBANCE OF THE ENVIRONMENT CAUSED BY ORE EXPLOITATION AND PROCESSING

a. Any deposit can be a powerful complex source of pollution

b. Strip mining of coal on the territory of Appalachia transformed a picturesque natural setting into a desert with gaping holes, slag heaps, and infertile barren earth.

c. Mining basins with exploitation of metallic mineral raw materials and their metalwork’s are great polluters of air, water, soil, and plant and animal life, above all with numerous toxic elements.

d. Thermal electric power plants and installations for coke production as a rule are heavy polluters of air, water, and soil. They are above all the greatest anthropogenic sources of heavy metals.

COMPLEX HARMFUL INFLUENCES OF URBANIZATION ON THE NATURAL ENVIRONMENT

a. First alarming signs of environmental pollution coincide with the process of urbanization, which is with the industrial revolution.

b. Greater pollution of the environment has been contributed by the constant growth in the number of inhabitants per unit of area and consequent increase in the amount of communal waste.

c. On entering the environment, waste participates in biological circulation, weakens the capacity for self-purification, and causes breakdown of ecological equilibrium.

d. Number of diseases increases precipitously in times of smog. Automobile exhaust fumes are the main cause of an especially dangers type of smog (photochemical or Los Angeles smog). Air takes on an unpleasant smell during photochemical smog, visibility worsens, the mucosa in humans is irritated, and the condition of sufferers from lung and other diseases deteriorates.

e. Street noise has a harmful effect on hearing. It also frequently contributes to serious disorders of the nervous system, somatic changes, and stress-linked diseases such as hypertension, impaired secretory work of the stomach and intestines, hormonal disturbances.

CONSEQUENCES OF THE ACTION OF POLLUTANTS ON MAN

a. For human concern consequences of pollutants can be classified as irritating, fibrogenic, allergic, dermal, toxic, mutagenic, carcinogenic and embryotoxic.

a. Key consequences of pollutant action are singled out in the book “Physicochemical Basis of Environment Protection” (D. Markovic et al., 1996):
i. Threat to life on the Planet, probably enhanced by possible decrease of oxygen in the atmosphere

ii. Threat to the survival of individual species of living organisms and indirectly to that of other organisms dependent on them

iii. Genetic changes of living species, especially man, that can lead to his demise as an intelligent and the currently reigning species

iv. Hindering of the existence and threat to the survival of individuals and the groups to which they belong; and

v. Direct and rapid negative action on individuals or narrower groupations.

b. Mechanisms of Toxic action

i. Depending on the amount of a given substance, it can be indifferent, medicinal, or poisonous on its action on the organism.

ii. Poisons enter the organism by means of inhalation, and ingestion or through the skin. Penetrating a living cell, poisons alter physico-chemical characteristics of the cytoplasm, destroy the membranes or organelles, change the reaction of the cell medium, and disturb the conditions needed for normal functioning of cell proteins.

ROLE OF ECOLOGICAL MINERAL SUBSTANCES IN ENVIRONMENT PROTECTION

c. Mineral raw materials and rocks in general in the raw state or after a certain degree of processing- play a significant part in environment protection.

d. Various non-metals such as zeolites, different kinds of clays and silicates, glauconites, granites, serpentinites, dolomites, limestone’s and marble are used as natural sorbents to remove suspended particles or dissolved substances from industrial waste.


THE GEOGRAPHY OF DISEASE

NON-INFECTIOUS SOMATIC DISEASES

I. Disease of the Heart and Blood Vessels

a. Most important diseases is heart disease and cerebrovascular disturbances.
b. Leading risk factors: ingestion of cholesterol and other animal fats, high consumption of kitchen salt, obesity and hereditary factors (hypertension), and increased consumption of sugar and fats.

II. Malignant Tumors
   a. Latest research suggests cancer next to Cardiovascular disease is the greatest killer in many industrially developed countries and originates from mostly environmental causes
   b. More than half of all malignant tumors occur in developed countries. Stomach is most often affected.

III. Infectious and Parasitic Diseases
   a. Cholera is believed to have caused the greatest number of deaths of all infectious diseases.
   b. Epidemiologists and other investigators tried to find the cause and attempted to classify various infectious diseases. Two significant discoveries include: The local diet affects the incidence of pellagra and that infectious diseases can be spread by polluted drinking water.
   c. Main goal of epidemiological geography is to discover objective laws governing the spatial distribution of infectious diseases.

RARE AND STRICTLY LOCALIZED DISEASES
   a. Strictly localized diseases remained for a long time in the shadow of rare diseases in the wider sense.
   b. For specialists in the area of geographic pathology and especially medical geology so-called rare and strictly localized diseases are particularly important because there is the real hope of linking their incidence or characteristics with some factor of the geographic or geological environment in the broader sense.
   c. Examples of rare and strictly localized Endemic diseases
      a. Kashin-Beck disease
      b. Kuru sickness
      c. Vilyui encephalitis
      d. Buruli pustules
   d. BIOGEOCHEMICAL ENDEMIAS
      a. According to the classification of Keller et al. (1993) the microelementoses of man belong to four basic groups:
         i. Natural endogenous ones congenital and hereditary
         ii. Natural exogenous ones, caused by a deficit, excess or disbalance of microelements
         iii. Technogenic ones, of the industrial-professional, neighborhood, and transgressive types and
         iv. Medico-elementoses (microelementoses associated with intensive therapy)
QUESTIONS CONNECTED WITH THE ETIOLOGY OF ENDEMIC NEPHROPATHY

a. According to S. Strahinjic (1985) endemic nephropathy represents a chronic slowly progressive disease that occurs in endemic foci and endemic regions and has a family-linked nature, unknown etiology, and inadequately clarified pathogenesis.

b. Causative factor is the crucial question in the case of endemic nephropathy. In order to establish it, living agents (bacteria, viruses, fungi) were tested initially, followed heavy metals.

c. According to Z. Maksimovic (1985) the geographic distribution of endemic nephropathy indicates that this disease is linked with the geochemical environment, as is also the case with other well-known endemic diseases of man.


ENVIRONMENTAL GEOCHEMISTRY ON A GLOBAL SCALE

a. Recent population growth and economic development are extending the problems associated with land degradation, pollution, urbanization, and the effects of climate change over large areas of the earth’s surface, giving increasing cause for concern about the state of the environment.

b. The speed and scale of the impact of human activities are now so great that, according to some authors, for example, McMichael (1993), there is the threat of global ecological disruption.

c. Geochemical data contain information directly relevant to economic and environmental decisions involving mineral exploration, extraction, and processing; manufacturing industries; agriculture and forestry; many aspects of human and health; waste disposal; and land-use planning.

ESSENTIAL AND POTENTIALLY HARMFUL CHEMICALS

a. Three groups of chemicals are of particular concern in relation to the Earth’s life support system: Essential and potentially harmful chemical elements; radioactive substances; and persistent organic pollutants.

b. Two main groups are of particular importance for health: those that are essential to animal life (K, Na, Ca, P, Cl, S, and N)

GENERATING A GEOCHEMISTRY DATABASE

a. Geochemistry can be used to identify, map, and monitor not only the total amount of substances in soil, dust, or water, but also the amount of a substance that is bioavailable and hence most significant in terms of likely human health effects.

b. Groundwater studies in particular tend to be carried out in isolation from those of surface water, stream sediment, or soil.
c. Some of the applications of data obtained from geochemical mapping include:
   a. Delineation of areas with mineral resource potential
   b. Identification of contaminated land
   c. Studies of water quality
   d. Studies of the environmental impact of agriculture and forestry.
   e. Assessment of acid drainage potential and other contamination from mines.

CONCLUSIONS AND RECOMMENDATIONS

a. Preparation of a systematic multimedia (surface and groundwater, soil and stream sediment) multi-determinand global geochemical database would make a major contribution to understanding and hence improving environmental quality worldwide. This would provide the best method of technology transfer, and for documenting and communicating information on the environment of particular regions and countries in a global context as a basis for sustainability.

Weinstein and Cook, 2007, Epidemiological Transitions and the Changing Face of Medical Geology, Ambio, v. 36, no. 1

INTRODUCTION

b. Medical geology defined as the study of the relationship between the geosphere and human health.

c. Aim of the paper to trace the changing role of medical geology through these epidemiological transitions, thereby providing, for the first time, a historical perspective on the importance of this field.

HUNTER-GATHERERS BEFORE THE EPIDEMIOLOGICAL TRANSITIONS

a. Hunter gatherers, humans moved around in small family groups and were dependent primarily on the direct availability of unmodified environmental resources.

b. Major determinant of the disease burden was resource dearth, which could lead to hardship (lack of tools), exposure (lack of shelter or fuel), famine (lack of food), and local extinction (lack of healthy mates)
FARMERS AND THE FIRST EPIDEMIOLOGICAL TRANSITION

a. Population size and density increased, as did the intensity of animal contact, setting the scene for infectious disease to take over as the major contributor to the human disease burden. This was known as the first epidemiological transition.

b. New food supply and associated sociocultural changes unfortunately also brought health problems of their own, and it is these that relate more directly to medical geology.

c. Iodine is deficient because iodine salts are generally very soluble. Iodine-deficient crops grew on such soils, and populations dependent on them were in turn iodine deficient.

INDUSTRIAL SOCIETIES AND THE SECOND EPIDEMIOLOGICAL TRANSITION

a. With industrialization came all the improvements in population health indicators associated with development: decreased child mortality, increased life expectancy, decreased birth rates and improved quality of life. These changes constitute the second epidemiological transition: an associated increase in the diseases of affluence, like cardiovascular disease and diabetes (which both result from inactivity and over nutrition).

b. Outdoor air pollution had overtaken indoor air quality as the dominant exposure environment to compounds detrimental to respiratory health, and people started dying.

GLOBALIZATION AND THE THIRD EPIDEMIOLOGICAL TRANSITION

a. The changes in disease burden associated with the disruption of health- sustaining ecosystem services have been described as the third epidemiological transition.

b. Lyme disease for example, a debilitating infection with the tick-borne pathogen Borrelia, has recently emerged as a major public health problem in the United States.

c. Many other human pathogens are either directly or indirectly dependent on soil ecology, and therefore also have the potential to emerge or reemerge as public health problems in areas where anthropogenic disruptions to soil ecology take place.

CONCLUSION

a. In agricultural and later industrial societies, medical geologists (albeit using different labels) made recommendations about in agricultural and later industrial societies, medical geologists made recommendations about maximizing soil yields and minimizing toxic pollution and human exposure.

b. The medical geologist of the future will be a multidisciplinary, able to span a breadth of geological (basic, applied, environmental), medical (clinical, epidemiological, sociological), and political sciences.

Appelton J.D. article has focused on Radon. Radon isotopes occur in 3 natural states Actinon, thoron and Rn (radon). The article discusses how the kinds of rocks and unconsolidated deposits that radon is associated with, how radon moves through the ground and into buildings, the associated health risks, and how to produce radon hazard maps.

High levels of radon emissions are associated with particular types of bedrock and unconsolidated deposits. The article discusses how radon can be linked to cancer. The number of lung cancer cases related to radon is estimated to be at 15,000-20,000 that makes up 10-15% of lung cancer deaths.

Radon mapping helps ensure the health of occupants that may work in radon prone areas are protected. Theses maps are used to assess whether radon protective measures may be required in new buildings for the cost effective targeting of radon monitoring in existing dwellings and workplaces, and to provide a radon assessment for home buyers and sellers.


The main topic of discussion in this article is Arsenic. It is said that Arsenic is the 20th most abundant element in the Earth’s crust. Humans can be exposed to Arsenic through diet or natural environmental sources. Elevated levels of Arsenic in drinking water have been reported in many countries around the world. The image below shows areas of the world that has reported Arsenic in aquifers, mines and geothermal waters.
The article states that inorganic arsenic is a well documented as a human carcinogen of the skin and lungs. Arsenic is a serious threat to humans all over the world. Medical geology has the ability to identify factors that could potentially result in an Arsenic outbreak.


Natural minerogenic dust is derived naturally from the land surface, mainly from the world’s dry lands. Inhalation of dust can cause a variety of pathological effects. The denser the dust and the longer the exposure increase the risk of chronic respiratory disease and associated death rates.

Selected case studies discussed in the article include nonindustrial silicosis also known as desert lung syndrome, Silicosis linked to tuberculosis, and nonindustrial asbestosis that upon inhalation can result in asbestosis, mesothelioma and lung cancer. The foundation of understating the impacts of natural minerogenic aerosols comes from the geologic and meteorological study of dust sources, sinks, transport and geochemistry.


Coal is one of the major sources of pollutants globally. Residential coal health impacts include fluorosis which can be most identified with the symptom of mottling of teeth enamel. Health impacts of in ground coal have been noted from lignite causing kidney disease. Uncontrolled fires can also have an influence on global health such as
greenhouse gasses and burning coal beds that can volatilize elements that can be inhaled and absorbed on crops and then eaten by livestock, birds and fish.

Black lung disease is popular among miners but has recently decreased dramatically in the United States. The pathology of black lung disease involves pyrites that dissolves in the lung fluids that release iron sulfate and strong acids that irritate the lung tissues. The irritated tissues may then cause the fibrosis leading to decreased oxygen exchange capacity.
INTRODUCTION

a. 3 naturally occurring radon (Rn) isotopes; Actinon, thoron and Rn commonly known as radon.

b. Article describes the kinds of rocks and unconsolidated deposits that radon is associated with, how radon moves through the ground and into buildings, the associated health risks, and how to produce radon hazard maps.

GEOLGOICAL ASSOCIATIONS

a. Relatively high levels of radon emissions are associated with particular types of bedrock and unconsolidated deposits

b. Releases from coal residues and the burning of natural gas and coal complete the list of major contributors to atmospheric radon in the US.

c. High concentrations of radon in houses and soil gas in the UK are associated with a) rocks and weathering products that contain enhanced levels of uranium or radium, and b) permeable rocks, unconsolidated overburden, and their weathering products.

d. In the Czech Republic, the highest indoor and soil-gas radon levels are associated with the Variscan granites, granodiorites, syenites, and phonolites of the Bohemian massif.

e. In Germany, the highest radon occurs over the granites and Palaeozoic basement rocks.

RELEASE AND MIGRATION OF RADON GAS

a. Most of the radon atoms formed from the decay of radium remain in the mineral grains. In soils, normally 20%-40 % of the newly generated radon atoms emanate to the pore space where they are mixed in the gas (soil air) or water that fill the pores.

b. After uranium and radium concentration, the permeability and the moisture content of rocks and soils are probably the next most significant factors influencing the concentration of radon in soil gas and buildings.

c. Radon containing soil air (or soil gas) is transported along natural pathways, which include planar discontinuities and openings, such as bedding planes, joints, shear zones, and faults, as well as potholes and swallow holes in limestone.
d. Radon transport by diffusion is not the cause of enhanced radon concentrations in dwellings, although diffusion may be more important in buildings with crawl spaces or those that lack a protecting concrete slab.

e. Radon decays in a few days, so water in rivers and reservoirs usually contains very little radon. Consequently, homes that use surface water do not have a radon problem from their water. Water processing in large municipal systems aerates the water, which allows radon to escape, and also delays the use of water until most of the remaining radon has decayed.

EXPOSURE AND HEALTH RISKS

a. Most of the exposures to terrestrial gamma-rays and to $^{220}$Rn and $^{222}$Rn decay products result from living indoors. Most of the radon that is inhaled is exhaled again before it has time to decay and irradiate tissues in the respiratory tract.

b. Apart from lung cancer, there is no epidemiological proof of radon causing any other type of cancer.

c. The number of lung-cancer cases from residential radon exposure in the US is estimated to be 15 000 to 22 000, which is 10%–15% of lung cancer deaths. Radon causes 11% of lung cancer deaths among smokers (most of whom die of smoking) but 23% of persons who never smoked.

d. The US Environmental Protection Agency estimates that radon in drinking water causes about 168 cancer deaths per year, 89% from lung cancer caused by breathing radon released from water, and 11% from stomach cancer caused by drinking radon-containing water.

e. In general, radon released from tap water and inhaled will present a greater risk than radon ingested through drinking water.

RADON HAZARD MAPPING

a. Accurate mapping of radon-prone areas helps to ensure that the health of occupants of new and existing dwellings and workplaces is adequately protected.

b. Radon potential maps can be used i) to assess whether radon protective measures may be required in new buildings; ii) for the cost-effective targeting of radon monitoring in existing dwellings and workplaces; and iii) to provide a radon assessment for home buyers and sellers.

c. Important to realize that radon levels often vary widely between adjacent buildings, because of differences in the radon potential of the underlying ground, as well as differences in construction style and use.

d. Two main procedures have been used for mapping radon-prone areas. The first is geological radon potential mapping in which each geological feature is assigned to a radon potential class based on the interpretation of one or more of the following types of data: i) radon concentrations in dwellings (indoor radon); ii) concentration, mineralogical occurrence, and chemical state of uranium and radium in the ground (radiometric and geochemical data); iii) rock and soil permeability and moisture content; iv) concentration of radon in soil gas, and v)
building architecture (construction characteristics). The second uses radon measurements in existing dwellings to map the variation of radon potential between administrative or postal districts, or grid squares, or within geological polygons.

e. Radon maps based on indoor radon data grouped by geological unit have the capacity to accurately estimate the percentage of dwellings affected together, with the spatial detail and precision conferred by the geological map data.


**INTRODUCTION**

a. Arsenic (As) is a ubiquitous element, and it is the 20th most abundant element in the Earth’s crust. Humans can be exposed to As through the diet or from natural environmental sources, such as contaminated groundwater, soils, or burning coal.

b. The health effects of chronic exposure to As are well established in countries with high levels of As in their drinking water; however, such evidence is not readily available in countries with lower levels of environmental As or with drinking water treatment systems.

c. United States are the potential health consequences of long- term low-level exposures via drinking water or through occupation, or wood treatments.

d. This paper is aimed at providing an overview of and a brief discussion of the available literature on global distribution of As as a research case on medical geology.

**BACKGROUND AND GLOBAL IMPLICATIONS**

a. Chronic As toxicity from drinking As-contaminated ground- water has recently been reported from many Asian countries.

b. Elevated levels of As were reported in water supplies of communities in Argentina, Austria, Brazil, Canada, China, Ghana, Greece, Hungary, Iceland, India, Japan, Korea, Malaysia, Mexico, Inner Mongolia, Nepal, Romania, Taiwan, Vietnam, Zimbabwe, and the United States.
c. By studying the geological and hydrological environment, geoscientists are trying to determine the source rocks from which As is being leached into the ground water. They are also trying to determine the conditions under which As is being mobilized.

GEOLOGICAL SOURCES OF EXPOSURE

d. As indicated previously, exposure to As may come from both natural and anthropogenic activities, including industrial sources, mining, medicinal sources, food, and beverages. Exposure to natural geological sources of As, including groundwater, geothermal springs, volcanic sediments, and As-rich coal led to the largest incidence of reportable poisoning cases in different parts of the world.

e. Significant amounts of As may also come from other tainted foods, ingestion of dust and from inhalation of indoor air polluted by As derived from coal combustion.

f. To understand the form, mobility, and transport of As from these natural geological sources, as well as to develop solutions to these problems, it is of critical importance to emphasize the need to obtain detailed chemical characterization of those natural geological sources where As may be present.

HEALTH IMPACTS FROM CHRONIC ARSENIC EXPOSURE

a. Inorganic As is well documented as a human carcinogen of the skin and lungs. Significantly high prevalence of skin cancer was observed in all arseniasis-endemic areas around the world, particularly in Asia.
b. Arsenic is a systemic toxicant known to induce cardiovascular diseases; developmental abnormalities; neurologic and neurobehavioral disorders; diabetes mellitus; mental retardation; ischemic heart disease; peripheral polyneuritis and polyneuropathy; peripheral vascular disease and limb gangrene; hypertension; hearing loss; and hematologic, gastrointestinal, renal, and respiratory disorders.

c. Single most characteristic effect of long-term oral exposure to In-As is a pattern of skin changes. These include a darkening of the skin and the appearance of nodular and diffuse lesions on the palms, soles, and torso.

d. Chronic As exposure from oral ingestion and inhalation has been associated with a variety of internal cancers involving the gastrointestinal tract, urinary bladder, lung, liver, and kidney.

e. Early recognition of As exposure and health effects may contribute to timely consideration of the As health risk and preventive measures.

CONCLUSION

a. Arsenic contamination through natural (geogenic) and anthropogenic sources is a serious threat to humans all over the world.

b. Natural sources of As exposure may include contaminated groundwater, volcanic sediments, coal, and spring thermal waters.

c. No human studies of sufficient statistical power or scope have examined whether consumption of As in drinking water at the current World Health Organization standard of 10 ppb results in an increased incidence of cancer or non-cancer effects.
d. Medical geology has the objectives of identifying harmful geologic agents; determining exposure relating to deteriorating health conditions; and developing sound principles, strategies, programs, and approaches to eliminate or minimize health risks, with particular focus on the naturally occurring physical and chemical agents in the environment.

e. Interaction and communication should be encouraged between the geosciences and biomedical/public health communities to seek novel solutions to better protect human health from the damaging effects of As exposure.


**DUST SOURCES**

a. Atmospheric aerosols include gases and liquids, as well as solid particles. They include material derived from oceans and landmass, as well as particles that form within the atmosphere, such as sulfates.

b. This paper considers only those dusts that are derived naturally from the land surface, especially in and around the world’s dry lands.

c. Given the present global warming trend, progressive desertification, and human actions that continue to increase the atmospheric dust loading, the intimate relations between aerosols and the global environment have obvious implications for future climatic change, and yet further indirect effects on human health around the world.

d. Detachment of mineral dust from the ground surface (‘‘deflation’’), and its entrainment and transport by the wind is a function of several variables, including wind speed, the degree of atmospheric instability, the size and shape of the particles, the roughness and moisture content of the land surface, and the degree of particle exposure.

e. Dominant dust sources around the world are almost wholly in or adjacent to the great dry lands of the northern hemisphere.

f. Determination of natural dust sources and concentrations on a regular basis is needed to establish background levels that can serve as a datum for detailed assessment of human and animal exposure levels.

**PATHOLOGICAL EFFECTS OF INHALED MINERAL DUST**

a. Pathological effects arising from inhalation of mineral dust varies with several factors, but the size, shape, and chemical and mineralogical composition of dust particles, the length of exposure of the subject, and certain lung functions are of notable importance.

b. The denser the ambient dust and the longer the exposure the higher are the rates of chronic respiratory disease and associated death rates.
c. Inhalation of the finer fractions of mineral dust eventually leads to deposition in the pulmonary alveoli where chronic lung disease is initiated.
d. Radiographic diagnosis of silicosis is made with confidence only after the appearance in a patient’s lungs of silicotic nodules 2–5 mm in size.
e. The group of lung diseases known as pneumoconiosis includes silicosis and asbestosis. Silicosis has attracted considerable attention as probably the most widespread of the occupational diseases. Asbestos is a group of fibrous silicate minerals that includes extremely fibrous serpentine or amphibole minerals found in a wide variety of geologic environments.

SELECTED CASE STUDIES

a. Nonindustrial Silicosis
   i. Nonindustrial silicosis has long been recognized in northeast Africa and the Middle East, where it is referred to as “desert lung syndrome,”
   ii. Saharan dust storms in the Canary Islands have given rise to cases of breathing disorders, including asthma, in autumn but especially in the late winter to early summer season.

b. Silicosis: Link to Tuberculosis
   i. Silicosis has some deleterious effects upon the immune system.
   ii. Long, continued exposure to silica has been linked to increased rates of infection with pulmonary tuberculosis
   iii. Data from the Thar Desert in northwest India show a prevalence of tuberculosis in the desert areas of Rajasthan that is some 25% higher than in the non-desert parts.

c. Nonindustrial Asbestosis
   i. Natural release of asbestiform minerals from the host rock occurs by the processes of weathering and erosion, the fibers frequently becoming concentrated by overland flow of surface water such as sheet wash and rilling.
   ii. The health effects of asbestos inhalation include asbestosis, mesothelioma (a cancerous tumor of the lung lining or pleural cavity), and lung cancer.
   iii. Asbestos fibers penetrate body tissue and remain in the lungs, lung lining, and abdominal cavity. Radiographically visible fibrosis may take as much as 15–20 years to appear following initial exposure.

CONCLUSIONS

a. The geologic and meteorological study of dust sources, sinks, transport, and geochemistry is an essential foundation for improved understanding of the extent and magnitude of the potential impacts of natural minerogenic aerosols on human health
b. The pathological effects of prolonged exposure to natural mineral dust have been recognized in a general way since ancient times, but the number of modern studies of pneumoconiosis outside occupation-specific contexts remains small.

c. The specific health effects of direct inhalation of high concentrations of fine minerogenic dusts, generated by natural deflation from loose, poorly bound soil surfaces, including those exposed by accelerated erosion of weak geologic formations such as loess, thus remain rather poorly known and relatively little researched.

d. Way of life is an important factor in any assessment of the health impact of respirable mineral dust because it directly affects dust generation, resuspension, and inhalation in many of the world’s dry lands.


**INTRODUCTION**

a. Coal will remain a key component of the global energy mix for decades to come as well as a major source of global pollutants

b. This paper discusses the facts and fallacies of the direct health impacts caused by coal

c. Most significant example of health impacts caused by trace element release from coal use occurs in Guizhou Province, southwest China, where millions of people suffer from dental and skeletal fluorosis and thousands suffer from arsenic poisoning due to mobilization of these elements by burning mineralized coals in unvented or poorly vented stoves.

**HEALTH IMPACTS OF RESIDENTIAL COAL USE**

a. Zheng et al. have shown that chili peppers dried over open coal-burning stoves may be a principal vehicle for the arsenic poisoning (9). In the autumn it is commonly cool and damp in the higher elevations of Guizhou Province. It is common practice for the residents of this region to dry their corn and chili peppers directly over these coal fires.

b. The health problems caused by fluorine volatilized during domestic coal use are far more extensive than those caused by arsenic.

c. Typical signs of fluorosis include mottling of tooth enamel (dental fluorosis: Fig. 1b) and various forms of skeletal fluorosis including osteosclerosis, limited movement of the joints, and outward manifestations such as knock-knees, bowlegs, and spinal curvature.
d. Belkin et al. describe a simple test kit than can be used at the mine to test the coal for its arsenic content. Improved economic conditions could help to alleviate these problems by allowing villagers to purchase commercial coal, briquettes, and modern stoves.

A HEALTH BENEFIT OF COAL COMBUSTION

e. Chemical analyses of the fuels indicate that the coal is markedly enriched in iodine. Burning the coal in the home to dry crops mobilizes the iodine and may provide a significant health benefit in preventing IDD.

f. Still much to learn about the impact of coal use on human health.

HEALTH IMPACTS OF IN-GROUND COAL

a. An unusual situation exists in the Balkans where there may be health problems caused by coal in the ground. Lignite has been cited as a contributory factor in a severe, debilitating kidney disease with associated urinary tract cancers.

HEALTH IMPACTS OF UNCONTROLLED FIRES

a. Global scale, the emissions of large volumes of greenhouse gases from burning coal beds may contribute to climate change that alters ecosystems and patterns of disease occurrence.

b. Regional and local scales, the emissions from burning coal beds and waste banks of acidic gases, particulates, organic compounds, and trace elements can contribute to a range of respiratory and other human health problems.

c. Burning coal beds also can volatilize these elements, which then can be inhaled, or adsorbed on crops and foods, taken up by livestock or bioaccumulated in birds and fish.
BLACK LUNG DISEASE

a. Incidence of coal worker’s black lung disease has decreased dramatically in the United States it still takes a heavy toll on coal miners in developing countries.
b. CWP may be initiated not by the coal particles but by inhalation of pulverized pyrite, a common coal mineral.
d. Pyrite dissolves in the lung fluids, releasing iron sulfate and strong acids that irritate the lung tissues. Particles that then contact the irritated tissues may then cause the fibrosis leading to decreased oxygen exchange capacity.
e. Knowledge of the mineral composition of the coal may be a key parameter in anticipating the incidence of CWP.

IF FLY ASH A HEALTH THREAT?

a. Combustion of coal produces enormous amounts of fine- grained respirable particles called fly ash.
b. Exposure to coal fly ash on a regular basis could present a significant health threat. Most modern coal burning power plants have sophisticated pollution control equipment that captures up to 99.5% of the fly ash produced during combustion.
c. There is one aspect of fly ash chemistry that deserves further attention. Recent studies have shown that some fly ash samples contain a very high proportion (as much as 50%) of hexavalent chromium, a very potent carcinogen.

RADIOACTIVITY FROM COAL: AN UNLIKELY PROBLEM

a. There have been reports in the scientific and public literature about the threat of radioactivity from coal and coal combustion products. One of the more serious accusations is that young boys playing near disposal sites of coal combustion by-products will be made sterile by the radiation.
b. The levels of radiounuclides in coal and coal combustion by-products are generally low to modest, commonly in the same range as many surficial rocks and soils.

CONCLUSIONS

a. The direct health problems caused by coal and coal use are generally local and potentially severe. Nevertheless, once identified, practical solutions are available.
Part 1. Short Answer Essay. Briefly define the following terms (use 4-5 long sentences minimum, in paragraph form). Provide examples where required. *Cite your references and sources for all of your answers, including Author(s) and year.*

1. **Medical geology (define, list and discuss three examples; cite references)** (5 pts)
   - The interdisciplinary field of "Medical Geology" responds to the need to better understand the relationships between human health and our surrounding environment. The influence of earth resources, natural environmental factors and land-use on human health has long been recognized, dating back to ancient Rome and Peru's Inca civilization.
     

   - Medical Geology, the study of the impacts of geologic materials and processes on animal and human health, is a dynamic emerging discipline bringing together the geosciences, biomedical, and public health communities to solve a wide range of environmental health problems.
     

   - Medical Geology is defined as the science dealing with the relationship between natural geological factors and health in man and animals, and understanding the influence of ordinary environmental factors on the geographical distribution of such health problems. Medical Geology is therefore a broad and complicated subject, which requires interdisciplinary contributions from different scientific fields if the problems are to be understood, mitigated or resolved.
     

2. **Essential elements (define, list and discuss three examples of health related concerns; cite references)** (5 pts)
   - Essential elements are needed for plant and animal life to live but there must only be trace amounts found. Too much or too little of an element can result into deficiencies or toxicities that cause health concerns. The table below is from an article showing the result of elements that are deficient or toxic. Magnesium, Iron and Zinc are among the essential elements listed below.
Fluorine in the correct amounts is able to stimulate bone formation and also reduce dental caries. However over exposure can cause fluorine of the enamel (molting of the teeth) and bone (skeletal fluorosis), which can include limited movement of the joints, and outward manifestations such as knock-knees, bowlegs, and spinal curvature. In pediatric patients fluorosis combined with nutritional deficiencies may produce severe bone deformation.


3. Non-essential (toxic) elements (define, list and discuss three examples of health related concerns; cite references) *(5 pts)*

- Arsenic a non-essential element is a human carcinogen. Exposure occurs through several anthropogenic sources, including mining, pesticides, pharmaceuticals, glass and microelectronics. Exposure to arsenic occurs via ingestion, inhalation, dermal contact and the parenteral route to some extent.
Pb (Lead) During the Roman Empire Pb usage exceeded 550 grams per person per year. Main sources being plumbing, architecture and shipbuilding. Lead salts were used to preserve fruits and vegetables and Pb was also added to wine to stop further fermentation and to add colour or bouquet (Nriagu, 1983). Pb however inhibits enzymes and alters cell metabolism, impairing heme synthesis and shortening the lifespan of red blood cells resulting in anemia (Ontario Ministry of Health, 1997)

Hg (mercury) this non-essential element at one point had many uses. During the Roman and pre-Roman times mercury was used during the Roman Empire to ease the pain of teething infants. Mercury was also used to treat syphilis during the 16th century and in the felting process in the 1800’s. The term “Mad as a Hatter” was deemed during this time due to long-term exposure to mercury led to mercury poisoning.

4. List the 5 principle goals of medical geology (cite references) (5 pts)

- To identify geochemical anomalies in soils, sediments, and water that may adversely impact human and animal health
- To identify the environmental causes of known health problems and, in collaboration with biomedical/public health researchers, seek solutions to prevent or minimize these problems.
- To evaluate the beneficial health effects of geologic materials and process.
- To reassure the public when there are unwarranted environmental health concerns associated with geologic materials or processes
- To forge links between developed and developing countries to find solutions for environmental health problems

5. Radon health risk (define, discuss origin and process of release, provide examples of health-related concerns; cite references) (5 pts)

Radon is a potentially hazardous natural gas. It's a decay product of uranium that easily migrates through the soil and in turn may leak into houses through crack and drains. Most common risk related to radon exposure is lung cancer. However radon released into the air rarely poses a threat unless released in poorly ventilated area. High levels of radon emissions are associated with specific types of bedrock and unconsolidated deposits, including some granites, phosphatic rocks, and shale’s rich in organic materials.

Reference:
6. Geophagia (define and provide examples, cite references) (5 pts)

Geophagia can also be referred to as pica, is the intentional or unintentional eating of soil or clay and is common practice in some cultures and countries, especially within Africa. Soil may be eaten from the ground, but in many situations there is a cultural preference for soil from special sources such as termite mounds. Geophagia often attempts to offset mineral imbalances or deficiencies and may also impair the intestinal uptake of trace elements such as Fe and Zn. Studies have shown in Turkish women that geophagia used as a supplement in diets have lead to Fe deficiency. Geophagia is considered by many nutritionists to be either a learned habitual response in which clays and soil minerals are specifically ingested to reduce the toxicity of various dietary components or as a built-in response to nutritional deficiencies resulting from a poor diet.

Resources:


7. List and discuss five natural (geologic) factors that impact human health (provide examples, cite references) (5 pts)

The geological environment consists of five components that are accessible to human activity are made up of 5 components: solid rocks, loose soil, groundwater, natural gases and microorganisms. All of the components interact with each other to create a dynamic equilibrium.

According to “The Ecology of Human Disease” there are stimuli’s such as inorganic, organic, and social and cultural stimuli. J. May the author states “a disease can arise only where factors of two kinds coincide at a certain point in time and space: first of all, factors that take the form of an environmental stimulus.

Inorganic stimuli include heat, humidity, the regimes of wind and light, and trace elements in soil, food, and water. Climatic and inorganic factors affect human health in two ways.

Reference:

Komatina 2004 Chapter 2 Overview Geological Factors that Effect Human Health (part1)
8. List and discuss five anthropogenic (man-induced) factors that impact human health (provide examples, cite references) *(5 pts)*

Negative environmental effects can be potential risk factors to human health. These include increased concentration of carbon dioxide through air pollution, destruction of the ozone envelope: the advent of acid rain, wasteful exploitation of natural resources, the action of heavy metals, radionuclides, and pesticides in water, soil, plants, and animals; cutting down of forests; and the expansion of erosive and desertification processes.

Agriculture (changes in soil), forestry (destruction of the forest), industry (industrial waste), construction (for natural resources) and mining (excavations of coal in vast quantities) are all ways that can have impacts on human health.

Reference:

9. List and discuss the three primary pathways by which humans may be exposed to natural or anthropogenic toxic elements/chemical compounds (provide examples of each, cite references) *(5 pts)*

Poisons enter the organism by means of inhalation, and ingestion or through the skin. Penetrating a living cell, poisons alter physico-chemical characteristics of the cytoplasm, destroy the membranes or organelles, change the reaction of the cell medium, and disturb the conditions needed for normal functioning of cell proteins.

Reference:

10. List and discuss four types of geologic hazards (natural earth processes) that have the potential to greatly impact human mortality (provide examples of each, cite references). *(5 pts)*

11. Discuss the exposure pathways and health risks associated with geogenic (naturally-occurring) arsenic (provide examples of symptoms and known problems globally, cite references). *(5 pts)*

Arsenic is toxic and carcinogenic. Most common symptoms seen are hyperpigmentation, depigmentation, keratosis and peripheral vascular disorders. Toxicity depends on the form of As ingested. Arsenic intake by humans is probably greater from food (seafood) than from drinking water but the arsenic in fish is of low organic toxicity. Drinking water represents by far the greatest hazard since the species present in groundwater
are predominantly the more toxic inorganic forms. Occurrences of high arsenic in drinking water are relatively rare. Incidences of high arsenic have been noticed particularly in Taiwan, South America, Mexico, India and Thailand.

Reference:

12. Discuss the exposure pathways and health risks associated with iodine deficiencies in drinking water (provide examples of symptoms and known problems globally, cite references). (5 pts)

The natural source of Iodine is seawater, additional sources are formation waters, fluid inclusions and volcanic emanations. Iodine is increased in the environment by man’s activities it is used in herbicides, fungicides, sterilants, detergents, pharmaceuticals and the food industry. Iodine is also released into the environment from fossil fuel combustion, car exhausts and from sewage.

20% of the daily iodine requirement of humans is likely to come from drinking water, the remaining 80% being derived from food. Dairy products, meat and fish are especially enriched in Iodine as is iodized salt where available.

The association of iodine deficiency in the human diet with endemic goitre has long been recognized. Goitre results from enlargement of the thyroid in order to compensate for iodine deficiency in hormone production. Kelly and Sneddon (1960) produced maps of the distribution of endemic goitre and found that almost all countries regardless of climate, race or wealth had some recorded evidence of the problem although for reasons stated above the problem today tends to be restricted to rural areas of developing countries. It has frequently been associated with mountainous areas, especially the Alps, Himalayas and Andes and regions distant from the coast.

Reference:

13. Discuss the biological function of the naturally occurring element calcium in the human body. Describe the range of physiological functions supporting by calcium in the system (cite references). (5 pts)

Calcium has many functions in the body. Studies are still discovering what new roles calcium takes. Calcium controls several developmental processes, and when cells have differentiated it functions to control such diverse cellular processes as metabolism, proliferation, secretion, contraction, learning and memory. The best known function of calcium is its being an integral component of bone and teeth phosphates.

Reference:
14. List and discuss four human health effects associated with mineral resource and petroleum extraction (mining and oil drilling). Describe the processes by which humans are exposed to health risks and the types of medical conditions associated therein (cite references). **(5 pts)**

Arsenic exposure can come from natural and anthropogenic activities including mining. Arsenic rich coal led to the largest incidence of reportable poisoning cases in different parts of the world. Arsenic mobilized through coal combustion caused severe health problems in China and Slovakia. Thousands of people in China’s Guizhou Province are suffering from severe Arsenic poisoning. The coals in this region have extremely high concentrations of Arsenic. Those affected displayed symptoms including hyperpigmentation, hyperkeratosis and Bowen’s disease.

Fluorosis is considered to be more extensive as far as health problems compared to arsenic. Typical signs of fluorosis including mottling of tooth enamel and various forms of skeletal fluorosis including osteosclerosis, limited movement of the joints, and outward manifestations such as knock-knees, bowlegs, and spinal curvature. However this does not come from mining but the use of coal-burning stoves used to dry foods.

Black lung disease or CWP is a progressive, debilitating respiratory problem caused by inhalation of coal dust. An estimated 600,000 Chinese coal miners are suffering from black lung disease and is said to increase about 70,000 a year. Recent research has shown that CWP may be initiated not by the coal particles but by inhalation of pulverized pyrite, a common coal mineral. The pyrite dissolves in the lung fluids, releasing iron sulfate and strong acids that irritate the lung tissues. Particles that then contact the irritated tissues may then cause fibrosis leading to decreased oxygen capacity.

Radon releases from coal residues and the burning of natural gas and coal are the major contributors to atmospheric radon in the US. High levels of radon emissions are associated with particular types of bedrock and unconsolidated deposits. Radon can be both ingested by drinking water and inhaled. However what poses the greatest risk is poor ventilation indoors. When radon is in inhaled it is exhaled before it has time to decay and irradiate tissues in the respiratory tract. Radon also makes up 10-15% of lung cancer deaths. 168 deaths per year are from radon cancer deaths 89% lung cancer and 11% stomach cancer from drinking water.

Reference:


Part 2. Long-Answer Essay

15. Discuss the concept of rock weathering and soil formation. In your discussion include the following aspects: (A) Chemical and mineralogic composition of typical rocks found at the Earth’s surface, (B) List and describe chemical and physical weathering processes involved? (C) Why is rock weathering and soil development critical for the health and survival of humans and animals on planet Earth? (Your answer should approximately fill the page space below at 12 pt font) (15 Pts).

The earth consists of a series of nested shells. The outermost thin skin, or crust, overlies a magnesium silicate-rich mantle, the largest mass of the planet. Beneath the mantle is the earth’s iron-nickel core. The terrestrial surface posses an atmosphere, global oceans and both continents and ocean basins. Solar energy absorbance and transfer mechanisms are responsible for the terrestrial climate and its variations, as well as for cyclonic storms and coastal flooding. The solid portions of the planet, the escape of buried heat through mantle flow has produced the earth’s crust, as well as energy and mineral deposits and all terrestrial substances necessary for life in the biosphere.

Earthquakes, volcanic eruptions and landslides are geological catastrophes that involve the earth’s layers. Most earthquakes are concentrated along plate boundaries. The continental lithosphere may be as much as 200 to 300km thick and is on average about 3.9 billion years old. As a consequence, these continent capped plates consist of a diversity of rock types with variable strengths, being transected by numerous discontinuities and zones of weakness, which reflect a tortured history of repeated rifting, crustal amalgamation, and mountain building. Volcanism is a consequence of partial melting of the down-going lithospheric plate at depths approaching or exceeding 100km. These magmas rise buoyantly into the earth’s crust in island arcs and continental margins where they form volcanic chains and subjacent batholiths. This is also region where plate convergence and contraction builds structural mountain belts, resulting in crustal thickening, rugged topography, and high erosion rates- such belts are characterized by landslides, mudflows, and other mass movements.

The earth’s crust constitutes far less than 1 percent of the entire planetary mass but represents the nurturing substrate for virtually all life on land much of the life in the oceans. To investigate and quantify the human health and longevity effects due to the presence and bioassimilation of earth materials, we need to understand the nature of the constituents that make up the earth’s crust, minerals and rocks. A mineral is a naturally occurring, inorganically produced solid that possesses a characteristic chemistry or limited range of compositions, and a periodic, three-dimensional atomic order or polymerization. Mineraloids is a naturally occurring solid or liquid that lacks a rigorous, periodic atomic structure and rocks are a naturally occurring, cohesive, multigranular aggregate of one or more minerals and/or mineraloids, making up an important mappable part of the crust at some appropriate scale. Surface interactions of minerals, mineraloids, and rocks with agents of the biosphere, atmosphere, and/or hydrosphere result in alteration of chemically reactive earth materials to produce a thin veneer of clay-rich soil the process called weathering. Weathering products provide the ready supply of nutrients and toxic chemical species that influence the existence of life in general and human health in particular. The weathering process results in removal and transportation of earth materials as soluble species in aqueous solution and as insoluble particles entrained in moving fluids (wind, water, and ice). The left residue left behind over time builds up a soil profile.
16. Summarize your understanding of the field of medical geology and its applications to public health. Frame your answer in the context of the readings and summaries you’ve completed for the 5 thematic units in the class. In the order listed, address the following components: (A) definition, overview and history, (B) health effects related to water quality and geochemistry, (C) health effects related to soils, biogeochemistry, and the food chain, and (D) two of your favorite examples of how geologic systems influence public health (Your answer should approximately fill the page space below at 12 pt font) (15 pts).

There are many definitions for the term “Medical Geology” but it basically is defined as the science dealing with the relationship between geological factors and health problems in humans, animals and plants. Medical geology is closely related to medical geography however medical geography looks at the geographical distribution of disease while not focusing on the underlying geology; it exams the causal associations between specific diseases and the physical and social environments. The field of study is complex and requires a multidisciplinary approach using a wide variety of specialists from geologists, geochemists and medical doctors to veterinarians and biologists. The relationship between geology and health has long been known. Ancient philosophers and physicians in countries such as Greece and China long ago realized the importance of how geology influences health. Hippocrates is considered to by most scientists to be the founder of medical geology. He recognized that environmental factors affected the distribution of diseases.

Freshwater environments are of major importance to health issues in both direct and indirect ways. Water resources are finite, and, though renewable, demands have multiplied over he last 100 years due to escalating human populations and the growing requirements of industry and agriculture. There are increasing global concerns over the extent of present and future. The impact of water quality on human health is highly complex. The factors involved include the environmental sources and pathways, the nature and rate of ingestion by humans, chemical concentrations, dose, and chronic and acute exposures to specific components. Three main areas to consider are inorganic components, man-made compounds or microorganics and biologic species that cause disease. Naturally occurring elements need to be watched careful to make sure there is not a deficiency or abundance in a living organism. The most serious water quality and health issues are associated with bacteria, parasites, viruses, and rotaviruses. The species proliferate in waters where there is inadequate sanitation or contact with contaminated water and from hosts that either live in water or require water.

Trace elements can be found in the soil that is then consumed by humans through food. Some of these nutritive elements essential to life can become toxic or even fatal in certain concentrations. A substance is considered poisonous if it prevents growth and metabolism of any organism when its concentrations exceed the norm. Soil formation is unquestionably the most important part of rock weathering from the human point of view. That active environment guarantee the entire biomass needed by humans, animals, plants, predetermining the existence of all life on land, including human life.

During my reading over the last couple of weeks I have found that many of the articles brought about a new view for me for viewing my patients and how some illness could be directly related to environmental factors. One article that I had found interesting “Health Impacts of Coal: Facts and Fallacies” had talked about the use of Coal and its potential pollutant effects. In parts of China the people there would dry chili peppers over open coal-burning stoves, which is risk for arsenic that could cause hyperkeretosis or dental fluorosis. In another article entitled “Radon: Sources, health risks, and hazard mapping.” What really caught my attention was how a product of uranium would be able to travel through the ground and buildings and be released into the environment. However even if inhaled that most of the product would be exhaled but radon had also been linked to lung cancer and caused 10-15% of lung cancer deaths.