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CONTRIBUTIONS OF IBN SĪNĀ TO GEOGRAPHICAL KNOWLEDGE

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Ibn Sīnā was an intellectual giant of the 10th-11th century. The Iranians claim him to belong to Iran, the Turks deem him to be a Turkish national, the Russians believe that he belongs to Soviet Union, and the Arabs consider him to be a citizen of the Arab World, but he was a national of none and yet belonged to every country. He was the cream and flower of humanity.

Ibn Sīnā was a great philosopher, an outstanding scientist, astronomer, and mathematician. He advanced the horizons of physics, chemistry, economics and political science, geology, and geography. He was a superb physician whose book *The Canon of Medicine* remained the most popular text-book for six centuries. He was a man of supernatural endurance and with a memory equal to the greatest on record.

Ibn Sīnā is, however, best known for his work *The Canon of Medicine*, and to the Western world he is known as a philosopher and the prince of physicians. What is, perhaps, less known about Ibn Sīnā is his work on geography and climatology.

Ibn Sīnā's views on the formation of mountains, rocks and fossils are contained in *De Mineralibus*, which is a translation of *Kitāb al-Shifā'* or *Book of the Remedy*, by Alfred Sareshal.

ORIGIN OF MOUNTAINS

In the time of Ibn Sīnā two theories were current about the formation of mountains and rocks. One of them considered the mountains to have been formed by the process of sedimentation, which later underwent denudation, valleys being carved in them by the process of erosion. The other theory considered the origin of mountains as due to the thrusting up of soil by imprisoned gas and erosion by water and wind.

Ibn Sīnā thought that the raised earth would be transformed into rock partly by the hardening of clay in the sun and partly by compression brought about by heat or by some unknown mineralizing, solidifying power. He advanced the hypothesis that mountains were formed from earth raised from sea floor.

It is surprising that a man writing in the 10th/11th century pre-empted the ideas current and accepted in the 20th century.

Modern thinking on the origin of mountains relates the evolution of mountains to geosynclines, where the rocks of the great mountain systems of the world originated as sediments laid down in sinking seas. The beds of the seas subsided during the accumulation of sediments in them. When the geosynclines were squeezed, long ridges arose, carrying up not only the sediments but also the floor of the geosynclines. Opinions are unanimous today that mountain ranges originated in geosynclines.

Mechanism of Mountain-Building

In the modern times there are a number of theories which attempt to explain the mechanism of mountain-building. Wegener's theory of continental drift, the geosynclinal-progenesis theory of Kober, the theory of radioactivity of Joly, the sliding continent theory of Daly, the convectional current theory of Arthur Holmes, and the latest theory in the field 'plate tectonics', refer to forces which folded and uplifted the mountains, in a description similar to the one given by Ibn Sīnā. In all the modern theories about mountain-building, we are as near or as distant to the truth as was Ibn Sīnā. Wegener refers to differential gravitational forces which were responsible for the drift of the continents which led to the crumpling of the sediments on the margins of the continents and which were subsequently raised as mountains. Joly's theory is wholly based on heat produced in the crust and the sub-stratum by radioactive elements, and tidal effects caused a movement of the soil masses leading to the folding of sediments on their margins into mountains. Daly invoked the force of gravity which led to the sliding of continents towards the geosynclines which compressed the sediments into mountains. Holmes has stressed the production of convection currents in the sub-stratum which resulted in ascending and descending currents. The outward flow under the continents led to a thickening of their soil margins and mountain-building was thus introduced. The plate tectonics, which is the most recent theory in the realm of mountain-building, divides the earth into six major plates, each moving relative to the other plates, with convergent and divergent boundaries. The convergent plate boundaries are also the sites of the world's major fold-belt mountain ranges.

Ibn Sīnā considers the mechanism of mountain-building as the pressure brought about by heat or some unknown mineralizing or solidifying power.

No one has yet been able to prove either the differential gravitational force for the movement of the continents, or the existence of currents in the sub-stratum. It would therefore be logical to conclude that we might have excelled in details but the current thinking upholds the basic hypothesis of Ibn Sīnā about the origin and mechanism of mountain-building.

Origin and Formation of Fossils

Ibn Sīnā's ideas on the formation of fossils are remarkable. He thinks that animals can be entirely transformed into stones if the bodies of these animals are in certain places where a mineralizing power is being exhaled. The elements which the bodies of these animals contained are transformed into the element which is the dominant element in them. The mineralizing power (which is the pressure to which the plants and animals remains are subjected) converts the terrestrial element into stone. The different external and internal parts of the animal keep their pristine shape. Ibn Sīnā's ideas have thus a close bearing on the modern theory of fossils.

Formation of Soils

Ibn Sīnā describes soil as the breakdown product of rocks of various kinds. Different kinds of soil differ in the size of their particles. It is the size of the particles which determines the movement or circulation of air and water through the soil. Ibn Sīnā points out that every kind of soil has its own effect on the atmosphere, water, and man. Perhaps what he means is that many health resorts owed their virtue not merely to the chemical composition of the water which is taken by the patients, but to the radiations, which pass outwards in those parts of the earth, producing a beneficial influence upon the patients as they walk over the ground.

Hydrology

Ibn Sīnā's views on ground water are revealing. He points out that ground water may move merely up and down or it may travel horizontally even to great distances. Its height varies with the rains, the seasons, the nature of the rock beneath, the character of the sub-soil and the presence of vegetation. He had a clear vision of the role of high water-table in creating waterlogged conditions and destruction of vegetation.

Climatology

While discussing the changes which seasons produce on the human body, Ibn Sīnā introduces such terms as 'ground air' and 'ground temperature' in his book *The Canon of Medicine*. These terms are found to be entirely accurate in the light of modern investigations.

He points out that in the pore space of the soil there is an abundance of vapour which moves in and out of the earth into the atmosphere. He pictures the earth as a huge lung which exhales ground air into the atmosphere and if the ground air is humid, owing to a high ground water level, the exhaled air will be damp. If the temperature of the earth is low, the exhaled air will be cold.

Modern climatology explains the phenomenon of heating and cooling of the lower layers of the atmosphere by the processes of conduction and convection. The layer of the atmosphere which remains in contact with the ground gets heated or

cooled as soon as the earth becomes hot or cold. Ibn Sīnā recognized the fundamental principle that the atmosphere is heated directly by the earth and indirectly by the sun.

Climatic Changes

To day there are many theories which are current about the climatic changes in the past. One of the latest theories is the sunspot theory which says that the development of sunspots leads to stormy conditions on the earth's surface and lowers the temperature leading to a cold climate.

Ibn Sīnā while analysing the solar and planetary influences on man refers to sunspots and says that there is a relationship between the character of the weather and terrestrial magnetic storms. The sunspots, according to Ibn Sīnā, have an 11-year cycle of climatic change, both in the earth's magnetic changes and in the sunspot cycle. To-day it is believed by scientists that the occurrence of sunspots has a frequency of 12 or 14 years. Ibn Sīnā describes the sunspots as tornadoes of white gas which affect both ultraviolet rays and electric radiation.

While discussing the effect of climate on man leading to various diseases in the *Canon of Medicine*, Ibn Sīnā had a clear idea about the factors which influence the climate of a place. He mentions them as terrestrial factors and includes (i) latitude, (ii) altitude, (iii) occurrence of mountains, (iv) distance from the sea, (v) exposure to wind, and (vi) nature of soil. These factors even today are considered relevant in determining the climate of a place with the exception of the nature of soil.

Perhaps more investigation needs to be done to determine the influence of the nature of soil on climate.

It may be appropriate to echo with Cameron Gruner, who translated parts of the *Canon of Medicine*, that we may step out of the world of the modern critic, the scholar, and the historian, into one in which we stand, hand in hand with the great Master of the East—almost with his very eyes gazing upon and scrutinizing the ever-open book of life of ours, divested of the false notions of 'progress' and 'time'. His language is thus no longer alien—and incidently he lives again !

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ERRATA

A. Article entitled "Computational Aspects of the Āryabhaṭa Algorithm" *by* Subhash Kak, in *Indian J. History of Science*, **21**(1) : 62-71 (1986)

Page 64 : The Congruences (4) should read as :

$(-1)^k . a' \bmod d_2 \equiv a$, and

$(-1)^k . b' \bmod d_1 \equiv b$,

B. Book Review

Page 194 : The year of publication of *Studies in Islamic Exact Sciences* is 1983 and *not* 1985 as printed