CRUSTAL EVOLUTION OF THE MOON, MARS, AND MERCURY:
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The origin of terrestrial continents remains an unsolved problem. Two competing theories are: (1) lateral accretion of orogenic belts and (2) early formation of sialic crust by igneous processes. A third possibility is that an originally global crust has over geologic time become fragmented and "oceanized", so that ocean basin growth rather than continental growth has been the dominant process. Comparative planetology suggests that the third concept, ocean basin growth, is in fact correct, to the extent that terrestrial crustal evolution parallels that of other silicate bodies.

The chief evidence for this interpretation comes from lunar geology. Physiographic similarities among Mercury, Mars, and the Moon imply that the Moon is a normal small terrestrial planet despite its close and so far unexplained relationship to the earth, and it can therefore be considered a typical example of early crustal evolution. Orbital X-ray fluorescence measurements, returned samples, and seismic data show that the Moon has a global feldspathic crust formed by igneous processes, now partly covered by mare basalts. Crater densities, radiometric ages, and stratigraphic relations indicate that this crust was formed in the first half billion years of the Moon's existence. Crustal evolution in the Moon thus began with a period of global differentiation by igneous processes.

The topography of Mercury, as shown by Mariner 10 imagery, and its density suggest a comparable crustal evolution for this planet: early global differentiation and crustal formation, basin-forming impacts, and eruptions of mare-like lavas. Heavy cratering characterized the early history of both Mercury and the Moon.

The crustal evolution of Mars shows the same pattern of initial events. Mariner 9 infrared spectroscopy (Hanel, et al., 1972) and television pictures indicate early formation of a differentiated crust by igneous processes, now represented by the ancient cratered terrain of the southern hemisphere. This crust, like that of the Moon, was disrupted by several major impacts, forming basins such as Argyre, and covered in the
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northern hemisphere by material inferred to be basaltic lava from its topographic similarity to flows in Mare Imbrium. The early geologic evolution of Mars up to this stage thus resembles that of the Moon and Mercury, although later events, such as formation of major tension fractures (Vallis Marineris) and volcanic piles of the Tharsis region, have no good lunar or Mercurian counterparts. It seems reasonable to infer that silicate bodies at least as small as the moon have similar early geologic histories, marked by global igneous differentiation followed by a major period of basaltic lava eruption. There is no evidence for the formation of patches of crust analogous to the sialic continental nuclei widely believed to have formed on the earth.

It is proposed that crustal evolution of the earth has been dominantly a process of ocean basin expansion. An originally global sialic crust, formed by igneous processes between 4 and 4.5 billion years ago, was disrupted by major impacts and tectonic fragmentation, followed by basaltic eruptions. This stage is entirely hypothetical, since there is no direct evidence of it surviving. Since that time, crustal evolution has been marked by growth of the ocean basins (at the expense of the continents), by sea-floor spreading, subduction, and recycling of the continental material (the latter causing loss of $^{87}$Sr to the mantle). The net result of the process has been a decrease in area but an increase in thickness of continental crust, illustrated by the Cenozoic history of the Andes and adjacent ocean crust. Lateral continental growth may be locally demonstrable, as in the ensimatic Franciscan assemblage of California, but is subordinate to ocean basin growth. Concentric isotopic age patterns interpreted as evidence of lateral accretion probably represent tectonic overprinting rather than new crust formation, since most geosynclines, both Precambrian and Phanerozoic, are underlain by old sialic crust.

In summary, it is becoming clear that study of the Moon has indeed taught us much about the earth.

Reference