

Geophysical constraints for the geochemical models of the Moon

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On the basis of geophysical constraints and method of mathematical modeling of phase relation and physical properties in the system CaO-FeO-MgO-Al₂O₃-SiO₂ [1], we examine the compositional models of the zoned Moon. We consider models of internal structure of the Moon with five layers including a crust, a three-layer silicate mantle, and a Fe-10 wt.% S-core ($\rho=5.7 \text{ g cm}^{-3}$). The mass and moment-of-inertia factor, bulk composition models and the hypothesis of magma ocean are used to model the internal structure of the Moon for three first-order parameters: (1) composition of the mantle; (2) core sizes and masses; (3) velocities and density in the upper, middle and lower mantle. The technique of Gibbs free energy minimization was used, and equations of state of minerals and solid solutions were included in the database [1,2]. The solution of the inverse problem is based on the Monte Carlo method. The bulk composition models of Ringwood, Taylor, O'Neill and others have been examined [1] and discussed. We determined the ranges of chemical composition, mineralogy, velocities and density in the upper, middle and lower mantle as well as core sizes. It has been shown that the chemical composition of the Moon bears no genetic relationship to the terrestrial material as well as to any of the known chondrites.

[1]. Kuskov O.L., Kronrod V.A. (1998), *Phys. Earth Planet. Inter.* **107** 285- 306. [2]. Kuskov O.L., Kronrod V.A. (2001), *Icarus.* **151** 204-227.

Microbial conversion of higher hydrocarbons to methane in different geosystems

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Since almost 20 years it is known from stable isotope studies that large amounts of biogenic methane are formed in oil reservoirs. The investigation of this degradation process and of the underlying biogeochemical controls are of great economical and social importance due to several reasons: (1) The understanding of reservoir biodegradation is of great use for the exploration industry, (2) a biotechnological stimulation of the methane formation in reservoirs could provide new economical perspectives. Even under optimal conditions, today not more than 30-40 % of the total oil in a reservoir is actually recovered. The majority remains in a polyphasic mixture with exploration water in the reservoir. The conversion of at least parts of this non-recoverable oil via an appropriate biotechnological treatment into easily recoverable methane would provide an extensive and ecologically sound energy resource. Laboratory mesocosm as well as high pressure autoclave experiments with samples from different geosystems showed high methane production rates after the addition of oils, single hydrocarbons or coals. The fingerprinting of the microbial enrichments with DGGE showed a large bacterial diversity while that of Archaea was limited to three to four dominant species. For the characterization of degradation pathways metabolite spectra will be analysed, combined with the use of labelled substrates. The mechanism of the first irreversible step of the degradation reaction, cleaving the carbon-hydrogen bond without oxygen, is analysed employing hydrogen and carbon isotope fractionation. The variability of carbon and hydrogen isotopes falls in a relative narrow range. Further we have analysed the isotope composition of methane in a confined mineral oil contaminated aquifer to test whether the isotope composition of methane can be used as an indicator for methanogenesis. The variability of carbon and hydrogen isotope composition was almost identical with those obtained with the enrichment cultures. Our stable isotope data from both, the incubations with samples from various ecosystems and from field studies, implies a common methanogenic biodegradation mechanism, resulting in consistent patterns of hydrocarbon alteration.