Planetary Cratering Histories: Moon, Mars, and the Questionable Cataclysm

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Absolute ages of planetary surface units can be estimated from impact crater densities. These crater retention ages are in good agreement with radioisotopic data from available planetary rock samples. Crater counts correctly predicted lunar mare ages about 3.6 Gy and a higher average cratering rate before Apollo and Luna samples were returned (Hartmann 1965, 1966), and Martian lava dating from the last few hundred My before recognition of Martian meteorites (Hartmann 1973, Hartmann et al. 1981). Martian meteorites from 4 to 8 Martian impact sites show yield igneous rocks and basaltic lavas with ages from 1300 to 170 My (Nyquist et al. 2001); crater counts on the youngest visible lava plains yield ages < 100 My.

Early planetary cratering remains enigmatic. Evidence is inconsistent on existence of a cataclysm at 3.9 Gy ago. Dates of several dozen impact melt clasts from six lunar meteorites by Cohen et al. (2000) and Cohen (2002) shows no peak at 3.9 GY at all, suggesting that parts of the moon (far side?) experienced no cataclysm. An alternate model is discussed.

References

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Sedimentary organic matter in aquifers: composition and reactivity

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Natural attenuation of percolating oxidants in groundwater systems is primarily controlled by the reduction activities of the aquifer sediment. The amount of sedimentary organic matter (SOM) in aquifer sediments is typically low (~0.1%) and little is known about the reactivity, chemical composition and distribution of SOM in aquifers.

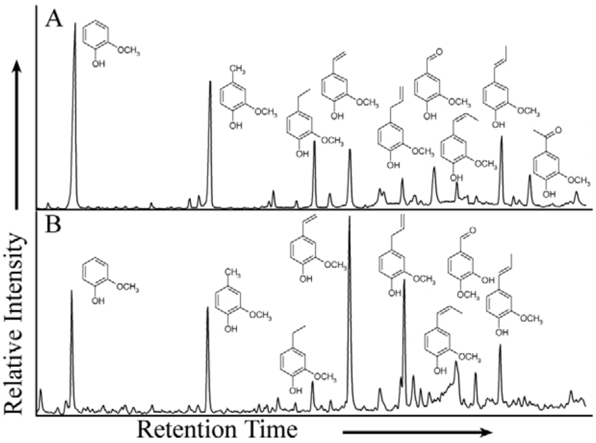

Figure 1 : Partial mass (*m/z* 124+138+150+152+164+166) chromatograms of SOM pyrolysates showing A: extensive side-chain oxidation of lignin-derived fragments B: more preserved lignin-derived fragments.

Sediments from various geological formations with a varying age and provenance were studied. Using pyrolysis-GC/MS analysis, we found the molecular composition of SOM to be mainly derived from terrestrial plants, as indicated by the major presence of long chain (C_{23}-C_{33}) *n*-alkanes and ketones, the odd/even predominance of the *n*-C_{27} to *n*-C_{33} alkanes and the importance of lignin-derived products.

Evidence for the oxidation of SOM was found in side-chain oxidation of lignin units (Fig. 1), products of long chain *n*-alkanes oxidation, i.e. methylketones, and the loss of functional groups in hopanoids. These observed degradation features originated during aerobic respiration.

During oxidation experiments, sediments containing less altered SOM were more reactive towards molecular oxygen (O_2) than those containing more oxidized SOM.

The exposure to O_2 during geological history (i.e. depositional environment and post-depositional history) determines the chemical composition of SOM and is thus a key control in the preservation and the reactivity of SOM in aquifer sediments.