

The oxidative breakdown of PAHs by manganese oxide tailings

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Introduction

The Kalahari Manganese Field, situated in the Northern Cape province of South Africa, represents the largest body of Mn ore in the world holding up to 80% of the world's Mn reserves. As a result of ore extraction processes, large quantities of fine, relatively pure Mn oxide tailings are generated. Despite being classified as a 'waste' the tailings material could be a valuable source of 'slow-release' oxidising capacity for the treatment of organically contaminated soils. Manganese oxides are one of the most powerful oxidants in terrestrial geochemical systems. They are involved in redox cycles in soils and waters, which are essential to nutrient cycling, humification, contaminant fate and mobility.

Polycyclic Aromatic Hydrocarbons (PAHs) are ubiquitous contaminants which are not easily biodegraded, largely as a result of their very low water solubility (Zhang *et al.*, 1995), and thus persist in soils and waters. There have only been limited studies conducted on the oxidation and degradation of PAHs by Mn oxides (Mihelcic and Luthy, 1988). In the present study the Mn oxide tailings materials were reacted with anthracene, one of 16 PAHs appearing on the USEPA priority contaminant list.

Discussion and conclusions

The results obtained using UV-visible spectrometry and gas chromatography mass spectrometry show anthracene is being oxidised to anthraquinone on the surface of the Mn tailings materials under certain environmental conditions. This is thought to be one of the few reported cases of anthracene oxidation by natural minerals.

References

- Mihelcic, J. R. and R. G. Luthy. (1988) *Appl. Environ. Microbiol.* **54**, 1182-1187.
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Processes in early planetesimals: evidence from ureilite meteorites

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Ureilites are primitive ultramafic achondrites composed largely of olivine and pigeonite, with minor augite, carbon, sulphide and metal. They represent very early material in the history of the Solar System and form a bridge between undifferentiated chondrites and fully differentiated asteroids. They show a mixture of chemical characteristics, some of which are considered to be nebula-derived (e.g. a negative correlation between Mg/Fe and $\Delta^{17}\text{O}$ that resembles that of the ordinary chondrites but at lower $\Delta^{17}\text{O}$ values) whereas others have been imposed by asteroidal differentiation. Carbon isotope data show a striking negative correlation of $\delta^{13}\text{C}$ values with mg# in olivine. $\delta^{13}\text{C}$ also correlates positively with $\Delta^{17}\text{O}$, and therefore this isotopic variation was probably also nebula-derived. Thus, oxygen and carbon isotope compositions and Fe-Mg systematics of each monomict ureilite were established before differentiation processes began.

Heated by decay of short-lived radioactive isotopes, the ureilite asteroid started to melt. Metal and sulphide would have melted first, forming a Fe-S eutectic liquid, which removed chalcophile elements and incompatible siderophile elements, and basaltic melts that removed Al, Ca and the LREE. Several elements show different abundances and/or correlations with Fo content in olivine, e.g. carbon shows a positive correlation in ferroan ureilites, and a weak or even negative correlation in more magnesian compositions. HSE such as Os and Ir also show different distributions, i.e. ureilites with Fo < 82 have very scattered Os and Ir concentrations, which reach high values, whereas ureilites with Fo > 82 tend to have much less scattered and overall lower Os and Ir abundances. A similar change in elemental behaviour is shown by the Fe-Mn relations in ureilitic olivines: those with Fo contents < 85 show a good negative correlation, whereas those with Fo > 85 show much greater scatter.

This suggests that a major change affected the parent body at a time when melting had reached relatively magnesian bulk compositions. We consider that this event may have been a "hit and run" collision in which the ureilite parent body collided with a larger object. During the collision, the ureilite mantle broke up catastrophically but re-accreted in a jumbled state around the still-intact core. Mg-rich basaltic melts that were in the process of being formed at the time of break-up were retained in part as melt clasts that re-accreted to the regolith and are found in polymict ureilites.