Rock varnish from different locations: an insight into the genesis using in-situ analytical methods

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Rock varnish, i.e. a thin coating on rock surfaces consisting of clay minerals cemented by Mn and Fe oxihydroxides, has still not been proven to have either a biological or geological origin or a combination of both. In order to elucidate overall formation mechanisms, we have investigated samples from the Mojave Desert, CA, USA, the Negev Desert, Israel, and the Knersvlakte, South Africa using microscopic and mass spectrometric techniques.

Microscopic investigations revealed the thickness of coatings to vary between 4 and 120 μm, being deposited on different types of host rocks. Within varnishes we studied internal structures such as layering and botryoidal structures. Element mass fractions and Pb isotopes were determined by in-situ femtosecond LA-ICP-MS. The data demonstrate that the ratios of Mn/Fe (0.04-20), Mn/Ba (4-300) and $(SiO_2+Al_2O_3)/MnO$ (0.3-18) exhibite strong variations. $^{208}Pb/^{206}Pb$ ratios of the samples from the Knersvlakte were significantly higher than those from the Negev Desert. Co, Pb, Ba and P were substantially enriched in all varnish samples compared to the upper continental crust. Chondrite-normalized REE patterns revealed significant positive Ce and small negative Eu anomalies (Fig. 1). This result strengthens the hypothesis of a direct aqueous atmospheric deposition, previously established for varnish samples from the Mojave Desert and Death Valley [1]. The positive Ce anomaly may be caused by a REE leaching reducing environment (Ce^{3+}) to an oxidizing environment (Ce^{4+}) where cerianite can precipitate [2]. Our investigations on element compositions and Pb isotopes indicate that the genesis of desert varnish is complex and processes may differ between different deserts.

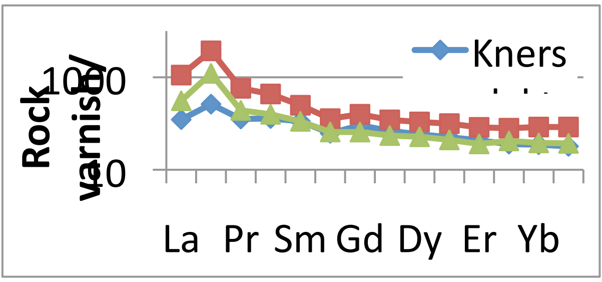

Fig. 1: REE patterns of varnish from different locations

[1] Thiagarajan & Lee (2004) *EPSL* **224**, 131-141 [2] Braun *et al* (1989) *GCA* **54**, 781-795