From Interstellar Ices to Polycyclic Aromatic Hydrocarbons
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Experimental studying aqueous alteration of polycyclic aromatic hydrocarbons – First results

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Aqueous alteration of minerals has been shown to occur in carbonaceous chondrites [1]. In particular the aqueous alteration of olivine is of major interest as multiple reactions can take place during this process. One group of organic molecules detectable in carbon-rich meteorites are polycyclic aromatic hydrocarbons (PAHs) [2]. These molecules are aromatic rings of carbon atoms with peripheral hydrogen atoms fused together to form honeycomb structures. In this study we have investigated whether aqueous mineral alteration can result in PAH alteration by simulating conditions in carbonaceous chondrites [3] in several experiment series.

Three PAHs (naphthalene $C_{10}H_8$, fluoranthene $C_{16}H_{10}$, coronene $C_{24}H_{12}$) and two types of olivine (powder from Gusdal olivine quarry in Åheim. Norway and slices from San Carlos Indian Reservation, USA) were used in batch reactor experiments. These reactors are polyfluorotetraethylene lined steel autoclaves with a total volume of $\sim$ 2 ml. We filled the reactors with olivine (powder or a solid slice), one type of PAH and ultra pure water. Subsequently we heated the filled batch reactors to 150 °C or left them at 21 °C. The experiment duration was 70 days. After exposure the samples were analysed by Raman spectroscopy and scanning electron microscopy.

The first results show different alteration effects in the samples. We observed strong variation between the different PAHs and experimental conditions. In the experimental series with olivine powder and PAHs a colour change of the sample was observed only in the fluoranthene experiment at 150 °C, indicating that the sample was alterated. In the case of olivine slices, however, we observed changes in samples with naphthalene and coronene. The control experiment of an olivine slice in water at 150 °C without added PAHs showed a brown coloured surface with serpentine minerals. In the experiment series at 21 °C these effects are not visible.

Under the experimental conditions examined, the reaction of olivine seems to be dependent on the PAH present. So far we have not directly observed alteration of PAHs, but the results are promising and further analyses may provide an answer to whether the aqueous alteration of olivine is associated with PAHs alteration.

REFERENCES

[1] Brearley A. J. (2006) Meteorites and the early solar system II, edited by Lauretta D. and McSween H. Y.Jr. Tucson: 587624.
[2] Sephton M.A. (2002) Natural Product Reports 19:292-311
[3] Zolensky M. E., Bourcier W. L., and Gooding J. L. (1989). Icarus 78: 411–425.