

Alteration of oil by gas: Experiments in fused silica capillary capsules

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Reservoir case studies showed that the fluorescence of oil inclusion assemblages of current or palaeo-gas zone has patterns that are not seen in zones that have only been invaded by oil [1, 2]. It is suspected that a fraction of the oil is retained in the pores when oil is drained by gas and that molecules from this residual oil partitioned in gas.

To attempt to reproduce the alteration of oil by gas, or gas-washing, we sealed small amounts of crude oil (59°, 42° or 33° API) and excess pure gas (methane, ethane, propane) in fused silica capillary capsules (FSCCs, [3]), with and without water. The UV-visible fluorescence spectra of oil phase(s) enclosed within the FSCCs were measured at temperatures of 20 to 100 °C, and Raman and FT-IR spectra of the gas and oil phases were measured at 20°C. With ethane and propane, the 33° API oil formed a new immiscible fluorescent liquid phase with fluorescence that is more blue than the initial oil, which became more yellow or disappeared or more blue when semi-solid residues formed. No or less solid residues formed in FSCCs without added water. Experiments with 59° and 42° API oil do not show immiscible hydrocarbon liquids. The fluorescence of those crude oils displays a yellow shift in presence of gas. Solid residues are minor.

We interpret for the residual oil (1) the decrease of fluorescence at short wavelengths (red-shift) as due to partitioning of low molecular weight aromatic molecules into the new immiscible liquid phase and/or vapour phase; (2) the decrease of fluorescence response at long wavelengths (blue-shift) as due to loss of high molecular weight aromatics by precipitation of solid residues; (3) the increase of fluorescence response at short wavelengths (blue-shift) as due to desorption of aromatics and resins from asphaltene. Water has effects on the precipitation of semi-solid residue and stability of oil phase in the lowest API gravity oil.

These results are consistent with the attributes of oil inclusions trapped in palaeo-oil zones that were displaced by gas and support the concept of gas-washing of residual oil.

[1] Eadington *et al.* (2008) *Geochim. Cosmochim. Acta* **72**, A236. [2] Bourdet *et al.* (2010) *Geochim. Cosmochim. Acta* **74**, A109. [3] Chou *et al.* (2008) *Geochim. Cosmochim. Acta* **72**, 5217-5231.

Conditions of metal-silicate segregation in the parent bodies of iron meteorites

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While there has been extensive work on the conditions of core formation on Earth, little work has focused on the conditions of core formation in the parent bodies of iron meteorites. A major obstacle to addressing this question is that the bulk compositions of the parent bodies are unknown and the iron meteorites do not represent directly the metallic liquid that segregated from silicates. Rather the iron meteorite compositions reflect various degrees of crystallization and fractionation of metallic iron. In some cases, there can be more than one liquid making the modelling more difficult.

By making the assumption that the bulk composition of the parent bodies was chondritic for the refractory siderophile elements, one can obtain a rough estimate of the size of the core and then estimate the corresponding oxygen fugacity of the parent body. In addition, using experimental determinations of the partition coefficients between metal and silicate, one can reconstruct the temperature and pressure conditions of metal-silicate segregation for various parent bodies. Using this approach, one can also estimate the abundance of volatile siderophile elements in the parent bodies of magmatic iron meteorites.

Due to the large number of assumptions made in this modelling, one can only obtain estimates for the oxygen fugacities, pressures and temperatures during core formation of the iron meteorite meteoroids. In the case of the IIIAB meteorites, the oxygen fugacity is close to IW-1.1 while it is IW-0.8 for the IVA magmatic iron parent body, which confirms the more oxidized nature of these parent bodies compared with the Earth (IW-2). In the case of the IVA irons, the best match is obtained for a volatile depleted bulk composition and the conditions of metal segregation has to be less than 1 GPa with a temperature ranging between 1600 and 1800 K. The siderophile element abundance of IIIAB requires a slightly higher temperature range and similarly low pressure.