3.4.P06

Temperature and chemistry of fluids in modern seafloor ore-forming systems: A case of fluid inclusion studies

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Fluid inclusion analyses from the Mid-Atlantic Ridge (the Logachev-1, Rainbow, Broken Spur active hydrothermal fields and relict “Mir” zone (TAG) and 5º55´N stringer zone) and the Manus (Vienna Wood), Lau and Woodlark basins (Pacific) are presented, with a focuss on temperature, salinity, and gas content. The fluid inclusions were trapped in anhydrite, barite, opal, epidote and clinozoisite, and include two- and three-phase inclusions. Some of the fluid inclusions are hydrocarbon-bearing. Anhydrite from the Logachev-1 field contains three-phase (liquid, a vapor bubble, and solid) and vapor-rich fluid inclusions. Salinity (in wt % NaCl-equiv.) in the inclusion fluids varies considerably: 4.2-26 (Logachev-1), 4.1-8.5 (Rainbow), 3.0-6.3 (Broken Spur), 4.6-6.5 (5º55´N), 1.6-7.6 (Vienna Wood), and 2.7-6.9 (Woodlark basin). Fluid inclusions homogenised at 102 to 398ºC.

Gas chromatography examination of gases extracted from fluid inclusions in sulfide minerals showed that the aqueous fluids contained methane, ethane, propane, i- and n-butane, and i- and n-pentane. The CH_4 and C_2-C_5 HC contents (cm^3 (STP)/g $x10^{-6}$) in fluid inclusions in sulfides from fields on the MAR range from 19.2 to 1181.0 and from 0.44 to 441.5. These values in fluid inclusions in sulfides at the back-arc spreading zones ranges from 1.59 to 74 and 0.15 to 105.7, respectively. CH_4 through C_3H_8 were detected in unaltered and altered magmatic rocks from several localities at MAR (15º20´N, TAG, Lacky Strike, Snake Pit, Logatchev-1).

The R/Ra ratios in fluids trapped by sulfides are of 5.2 to 7.2 (Rainbow), 5.6 to 8.3 (Logatchev-1), 4.6 to 7.1 (Broken Spur), 4.6 to 7.3 (“Mir” zone, TAG). These values in fluids capsulated in sulfides from back-arc setting is 3.05 to 4.3 (“Vienna Wood” field), 6.7, 5.1 and 7.7 (“White Tower” and “Died Wood”, Manus Basin), 5.3 (central Lau Basin), 3.1 to 4.5 (northern Lau Basin).

Temperatures and salinity of inclusion fluids show a stronger variation than fluids analysed at venting sites. Salinity of fluids that is higher and lower than seawater is explained by fluid phase separation. The R/Ra ratios indicate a contribution of mantle helium into fluids. A correlation between the CH_4 content and the He isotopes is indicative of a common source. The hydrocarbons may have an abiogenic origin due to sea water CO_2 reduction during water/rock interaction.

3.4.P07

Trace element degassing during the 2000 eruption of Hekla volcano (Iceland)

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Volcanic emissions are an important source of volatile elements, gases and aerosols into the atmosphere. In order to better understand the environmental impact of such emissions, the volatility and mobility of several trace elements released during Plinian eruptions are evaluated by chemical analysis of the gas phase at Hekla volcano. The early explosive phase of the 2000 Hekla eruption emitted a mixed tephra-gas plume that was condensed and scavenged by snowstorms. We present geochemical data on trace elements (metals, metalloids and especially the REE) and halogens in snow samples collected shortly after the beginning of the eruption, representing the chemical composition of the gas plume.

Enrichment of elements in volcanic gases is calculated by an enrichment factor (EF) relative to Be. This classification of volatility and correlations between different trace element and halogen contents show that enrichment in eruptive gaseous plumes depends not only on the magma composition and its temperature but also on the degassing of different volatile compounds. Moreover, REE spectra normalized to the 2000 lava show an enrichment of HREE over LREE. All these observations suggest that the chemistry of the gas phase of the volcanic plume of Hekla is dominated by two contrasting processes: 1) primary magmatic degassing during which the most volatile elements (e.g., As, Pb, Bi, Tl, Te) are exsolved as chlorides, fluorides and/or metals; 2) partial dissolution of tephra grains in the F-rich, acid plume of Hekla causing leaching of the least-volatile elements (e.g., REE, Th), as fluoride complexes. Thermodynamic calculations, as well as leaching experiments, confirm the importance of the latter process.

This study suggests that secondary processes such as leaching of tephras grains in a volcanic plume, are responsible for the mobility of refractory elements during degassing processes. Hence, in order to evaluate environmental impact of volcanic emissions, not only the primary degassing of volatile compounds must be taken into account, but also the partial dissolution of tephra grains in the eruptive plume.