## 3.4.P04

# Processes controlling Sr surface waters and geothermal solutions in a Tertiary tholeiitic floodbasalt province in Iceland

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Strontium concentrations of 253 natural water samples from Skagafjördur, a Tertiary tholeiitic flood basalt region in N-Iceland range between 0.10 and 28 ppb. Surface environments (rivers, lakes, and peat soil waters) include the whole range of observed Sr concentrations whereas the Sr concentrations of ground waters are in most cases less than 3.5 ppb. Concentrations of rock derived strontium in rivers and lakes exhibit a near linear correlation with concentration of rock derived Ca. The systematic correlation between Ca and Sr in rivers and lakes suggests that the concentrations of these elements are controlled by weathering processes in these environments, i.e., the extent of incongruent dissolution of the bedrock. The relative mobility of Sr during weathering in Skagafjördur is approximately half that of Ca, which is consistent with observed relative mobilities of these elements elsewhere in Iceland and in other basaltic regions. Molar ratios of rock derived Ca to Sr of peat soil waters exhibit no systematic pattern. Peat soil waters commonly have lower concentrations of Sr and higher Ca concentrations than rivers and lakes. The data suggest the presence of both a geochemical sink for Sr and an unusually high rate of Ca release, likely due to preferential dissolution of clinopyroxene in the peat soil environment. The narrow range of low Sr concentrations in ground waters suggests mineralogic control over Sr in the ground water systems. Precipitation of secondary strontium minerals such as strontianite and celestite is ruled out as the ground waters are under saturated with respect to these minerals. Incorporation of Sr as a minor or trace element into other secondary minerals is, thus, the most probable process controlling Sr concentrations in the ground waters. The ground waters are characterized by high Ca/Sr molar ratios (~5000 compared to bedrock Ca/Sr ratio of 730) suggesting that Sr is being preferentially incorporated into secondary minerals. The secondary minerals present in the bedrock in Skagafjördur that can preferentially incorporate Sr include zeolites, such as heulandite, chabazite, and thomsonite, and smectite. Ion-exchange calculations show that the activities of $Sr^{2+}$ and $Ca^{2+}$ in ground water solutions in Skagafjördur are consistent with ion-exchange equilibria between these waters and typical heulandites from Tertiary basalts in eastern Iceland (typical with respect to Ca/Sr ratio) suggesting that this mineral may play an important role in controlling the concentration of Sr in the Skagafjördur ground waters.

## 3.4.P05

# Seep geochemistry and origin of petroleum from the Salton Sea Geothermal System, California, USA

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Brines, mud, gas and hydrocarbons are seeping from the Salton Sea Geothermal System (SSGS) in Southern California. Field measurements and geochemical analyses of the seep fluids reveal considerable local variations in temperature, pH, density, and solute content. The temperature range is from 15 to 63 ºC in a 130x130 m large area, whereas the salinity in the same region varies with an order of magnitude. Halogen geochemistry of the waters show a component derived from dissolution of evaporates originating from the upper hydrothermal brine reservoir in the SSGS. Gas geochemistry shows that $CO_2$ is derived from decarbonatization reactions ($\delta^{13}C$ = -5.3‰), $CH_4$ and $C_2H_6$ ($\delta^{13}C$ = -31.5 and –20.5‰ respectively) are derived from maturation of organic material. The 11‰ difference in $\delta^{13}C$ values between $C_1$ and $C_2$ is in line with worldwide observations of unaltered thermocatalytic gas generated from naturally maturing organic-rich lithologies, and is consistent with the presence of petroleum (60% saturated, 25 % aromatic, and 15 % resins+asphaltens) in a few of the seep structures. This puts emphasis of the role of maturing organic matter in controlling local seep composition. The origin of the petroleum in the SSGS contrasts to many other hydrothermal petroleum systems *e.g.*, in the Guyamas Basin (Gulf of California). Our data emphasizes the complex plumbing system of the seep field. The SSSG seep field, used as a natural laboratory, may provide important insight into seep systems that cannot easily be monitored in detail, *i.e.* in submarine settings.