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The source and age of ground waters in the basalt area of Skagafjördur, Iceland, as deduced from data on natural chemical and isotopic tracers

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Data on natural tracers (Cl, B, Mo, W, δ^2H, δ^{18}O and ^{3}H) in ground waters and in <90°C geothermal waters, in the Tertiary-Quaternary tholeiite basalt province of the Skagafjördur valley system in northern Iceland, have been used to identify the origin of these waters, determine their age, and delineate flow directions. The use of the chemical tracers to identify the origin of the waters rests on the assumption that both Cl and B act as conservative. On the basis of this assumption, it is possible to calculate the fraction of Cl and B in the waters derived from sea salts on one hand and that leached from the basalts on the other. The basalt-derived Cl and B concentrations in the waters increase linearly with those of Mo and W. This correlation is considered to substantiate the assumption that both Cl and B act as conservative in the basaltic environment of the study area.

δ^2H-values and the concentrations of precipitation-derived Cl in waters emerging on the east side of the Skagafjördur Valley indicate that they originated as precipitation falling on the high mountains on this side of the valley. These waters generally do not contain detectable ^{3}H. Available global permeability data indicate that these waters are 100´s to 1000´s of years old. Waters emerging on the west side of the Skagafjördur Valley represent a mixture of present-day local precipitation and Pre-Holocene water, as deduced from the δ^2H-values and the precipitation-derived Cl of these waters. Some of these waters do not contain detectable tritium but others do, presumably due to the presence in them of a component that is a few decades old at the most. The δ^2H-values of these waters are typically more negative than that of any precipitation in Iceland today. The geothermal waters on the west side of the Skagafjördur valley, which have higher temperatures than those on the east side of the valley, are associated with fractures that dissect the Tertiary bedrock. Presumably, the component represented by the present-day precipitation convects in these fractures, but the Pre-Holocene component seeps into them from the surrounding bedrock where it has been residing for a long time due to the low global permeability. In the interior highlands, where the bedrock is Quaternary, and the global permeability higher than in the older basalts exposed in the Skagafjördur Valley, Cl data and δ^2H-values indicate that both thermal waters and ground waters are local precipitation by origin.

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He - C relationships in geothermal waters from the North Anatolian Fault Zone (NAFZ), Turkey

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Following the catastrophic earthquakes along the NAFZ in 1999, we initiated a periodic monitoring program targeting geothermal fluids (from boreholes and natural springs) for their chemical and dissolved gas characteristics. Our aim is to examine if chemical variations in the fluids are associated with the timing, location and/or depth of seismic activity along the NAFZ. Here, we report helium and carbon results (from late 2001 through 2003) collected at 9 locations along an 800-km transect - from Yalova on the Sea of Marmara to Resadiye in eastern Anatolia.

The major dissolved gas phase in the fluids is CO_2. Its concentration falls between 0.02 – 3.02 cm^3 STP/g H_2O. For the most part, CO_2 abundances are remarkably constant at any given location allowing sample locations to be subdivided into locations with high CO_2 (> 0.5 cm^3 STP/g H_2O: Bolu, Efteni-Gölyaka, Kurşunlu-Çavundur, Mudurnu, Reşadiye and Seben) and low CO_2 (< 0.12 cm^3 STP/g H_2O: Gözlek, Hamamözü and Yalova). The low CO_2 localities show low (mantle-like: ~10^4) $CO_2/^4$He values (from 3.9×10^3 to 1.3×10^5), whereas high CO_2 fluids have significantly higher, crustal-like (>10^5) $CO_2/^4$He values (1.1×10^5 to 3.7×10^8).

The isotopic composition of CO_2 (δ^{13}C) ranges from –4.5‰ to +5.8‰, with the majority of samples falling between –3.5‰ and 0‰. The low CO_2 samples tend to show higher δ^{13}C values (average = –0.5‰) versus high CO_2 localities (average = –1.7‰). Helium isotope studies are on-going but prior work [1] has shown that all localities are characterized by a mantle input, with ^{3}He/^{4}He varying between 0.22 R_A (Seben) and 2.2 R_A (Mudurnu) (R_A – air ^{3}He/^{4}He).

Seismic activity throughout the monitoring period remained fairly constant (~11 quakes/month) but there were periods (e.g. Jan. & Oct. 2002 and Jan., Mar., Apr. & Nov. 2003) when the frequency of events doubled to ~26 quakes/month. During the seismicity-active month of October, 2002, most locations showed a 0.5‰ to 3‰ drop in δ^{13}C values and, in Seben, a concomitant drop in $CO_2/^4$He was recorded. Presumably, this reflects a change in the balance between mantle-derived and crustal volatiles. We are continuing to search for other trends in the database which can be correlated with seismic activity.

References

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