The origin of the fluids circulating over the Amik Basin (Turkey) and their relationships with the Dead Sea Fault

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The Amik Basin is an asymmetrical composite transtensional basin developed between the seismically active left-lateral Dead Sea Fault (DSF) splays and the left-lateral oblique-slip Karasu Fault segment during neotectonic period. The relationship between the DSF and the East Anatolian Fault Zone is important as it represents a triple junction between Arabian Plate, African Plate and Anatolian Block in which the Amik Basin developed. The basin was formed on a pre-Miocene basement consisting of two rock series: Paleozoic crustal units with a Mesozoic allochthonous ophiolitic complex and ~1300 m thick Upper Miocene-Lower Pliocene sedimentary sequence. Plio-Quaternary sediments and Quaternary volcanics unconformably overlie the deformed and folded Miocene beds. Quaternary alkali-basaltic volcanism, derived from a metasomatized asthenospheric or lithospheric mantle, is most probably related to the syn-collisional transtensional strike-slip deformation in the area. Active faults in the region have the potential to generate catastrophic earthquakes (M>7).

Nineteen samples of cold and thermal groundwaters have been collected over the Amik Basin area for dissolved gas analyses as well as two samples from the gas seeps, and one bubbling gas from a thermal spring   Samples were analysed for their chemical and isotopic (He, C) composition.

On the basis of their chemical composition, three main groups can be recognized. Most of the dissolved gases (16; Group I) collected from springs or shallow wells (< 150 m depth), contain mainly atmospheric gasses with very limited H_2 (< 80 ppm) and CH_4 (1– 2700 ppm) contents and minor concentrations of CO_2 (0.5–11.2 %). The isotopic composition of Total Dissolved Carbon evidences a prevailing organic contribution with possible dissolution of carbonate rocks. However the CO_2-richest sample shows a small but significant deep (probably mantle) contribution which is also evidenced by its He isotopic composition. Further three samples, taken from the northern part of the basin close to Quaternary volcanic outcrops and main tectonic structures, also exhibit a small mantle He contribution (Fig. 1).

The two dissolved gases (Group II) collected from deep boreholes (> 1200 m depth) are typical of hydrocarbon reservoirs being very rich in CH_4 (> 78 %) and N_2 (> 13%). The water composition of these samples is also distinctive of saline connate waters (Cl- and B-rich, SO_4-poor). Isotopic composition of methane ($\delta^{13}C$ ~ -65‰) indicates a biogenic origin while

He-isotopic composition points to a prevailing crustal signature for one (R/Ra 0.16) of the sites and a small mantle contribution for the other (R/Ra 0.98) (Fig. 1).

The three free gas samples (Group III), taken at two sites within the ophiolitic basement west of the basin, have the typical composition of gas generated by low temperature serpentinisation processes with high hydrogen (37–50 %) and methane (10–61 %) concentrations. While all three gases show an almost identical $\delta D\text{-}H_2$ of ~ -750‰, two of them display an isotopic composition of methane ($\delta^{13}C$ ~ -5‰; δD ~ -105‰) and a $C_1/[C_2+C_3]$ ratio (~100) typical of abiogenic hydrocarbons and a significant contribution of mantle-type helium (R/Ra: 1.33). The composition of these two gasses is comparable to that of the gasses issuing in similar geologic conditions (Chimera-Turkey, Zambales-Philippine and Oman ophiolites). The gas composition of the other site evidences a contribution of a crustal (thermogenic) component ($\delta^{13}C\text{-}CH_4$ ~ -30‰; $\delta D\text{-}CH_4$ ~ -325‰; $C_1/[C_2+C_3]$ ~ 3000). Such crustal contribution is also supported by higher N_2 contents (40% instead of 2%) and lower He-isotopic composition (R/Ra 0.07) (Fig. 1).

These first results highlight contributions of mantle-derived volatiles possibly drained towards shallow levels by the DSF and other parallel structures crossing the basin showing a tectonic control of the fluids circulating within the Basin .

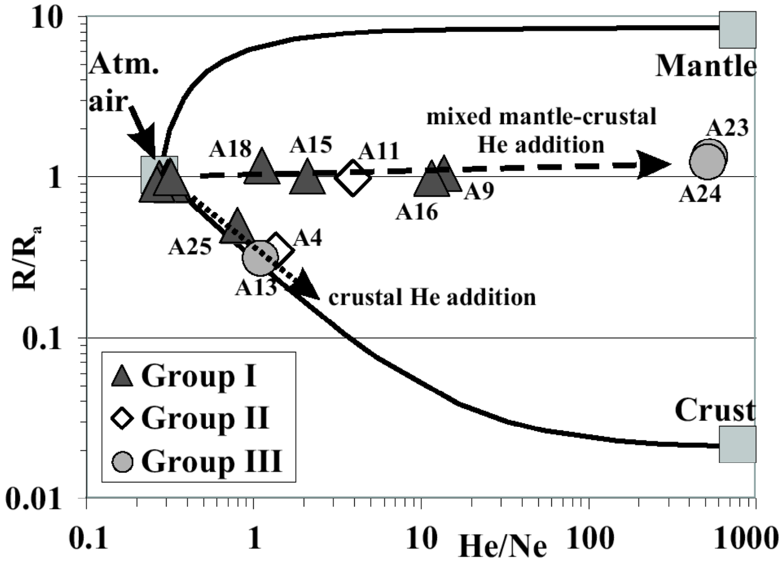

Figure.1 Helium isotopic ratios (as R/Ra values) and He/Ne relationships.

Acknowledgements: This work has been funded by the Scientific and Technological Research Council of Turkey (TUBITAK) with the project no 111Y090.