A noble gas record of groundwater recharge, paleoclimate, and mantle degassing in the North China Plain

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The North China Plain (NCP) is the largest alluvial plain in East Asia. It is one of the most densely populated areas of the world with great agricultural importance for China. The climate is continental semi-arid, with most of the about 600 mm/yr of precipitation falling during the East Asian monsoon season in summer. Intensive groundwater use for irrigation has led to strong drawdown of the potentiometric surface.

The study of the aquifer system in the NCP, in particular of groundwater recharge and its dependence on climate conditions, is therefore of vital interest. We present noble gas, stable isotope and radiocarbon data from 52 groundwater wells in the NCP that provide information on groundwater recharge in the piedmont plain, paleoclimate in the central plain, and mantle He degassing in the coastal plain.

In the unconfined aquifer of the piedmont area, tritium-bearing waters with ^{3}H-^{3}He ages younger than 40 yr are found down to depths of more than 100 m, indicating rapid vertical infiltration. The corresponding recharge rate of about 1 m/yr exceeds precipitation and can only be explained by recycling of groundwater pumped for irrigation. Effects of the anthropogenic modification of the recharge regime are also apparent in Ne excesses and stable isotopes.

Paleowaters with ^{14}C ages up to nearly 40 kyr are found in the deep confined aquifers of the central plain. Noble gas temperatures indicate a glacial cooling of 4 - 5 °C relative to the holocene. However, the coldest period of the last glacial maximum is not represented in the record, presumably because recharge was limited during this extremely arid phase. Depletion of the stable isotopes in the paleowaters can be ascribed to cooling and increased monsoon intensity.

The deep groundwater from the coastal region is near the limit of ^{14}C dating and exhibits the highest He excesses. While the excess He in the central plain has a radiogenic signature ($^{3}He/^{4}He = 6\cdot10^{-8}$), the $^{3}He/^{4}He$ ratio increases in the coastal plain by an order of magnitude. This unusual feature clearly indicates the presence of a mantle He component, which can be attributed to known fault zones. Mantle He has also been observed in hydrocarbons from this area.

B isotope study on Tourmalines and Axinites in hydrothermal systems: Insights into fluid circulation

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Boron isotope compositions were determined in tourmalines and axinites from three different geological contexts in Western Anatolia, linked by the emplacement of granitic intrusion at crustal levels.

In Kadıkalesi (Bodrum), tourmalines in a Late Miocene monzodioritic pluton have low $\delta^{11}B$ (-9‰), whereas torumalines hosted in veins cutting the intrusion and in younger aplitic dikes show higher values of -6 ‰.

In Sinancılar, Menderes Massif, magmatic tourmalines of Early Miocene granitic-granodioritic body, and those belonging to late veinlets cutting the granite, have similar values ($\delta^{11}B\approx$-4‰), whereas a progressive $\delta^{11}B$ lowering is observed in tourmaline veins in host rocks away from the plutonic body (-7‰).

Thus, $\delta^{11}B$ increasing in late hydrothermal tourmaline is observed in Bodrum, and the opposite is found in Menderes Massif. This different behavior between magmatic and late magmatic-hydrothermal tourmaline suggests that $\delta^{11}B$ variations are mainly controlled by different proportion between magmatic and hydrothermal fluids, more than fluid-mineral isotope fractionation.

In Maden Adası (Ayvalık), an Early-Middle Miocene volcano-sedimentary complex was subjected to extensive contact metamorphism. Axinites cristallized in Calc-silicate rocks of thermo-metamorphic aureola, from low-T to high-T rocks. The systematic variation of $\delta^{11}B$ from -12.6‰ in the lower metamorhic degree samples to -7‰ in the higher temperature rocks, is mainly attributed to B isotope fractionation between circulating fluids and mineral.

Therefore, fluid-mineral boron isotope fractionation seems to play a major role when different B coordination occurs between fluids and crystallizing phases, like trigonal-B in fluids and tetragonal-B in axinites, wheras it is less important in the fluid-tourmaline (both trigonal-B) system.