He isotopes and geodynamics of the Mexican Pacific coast

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Theoretically, the subduction of the oceanic plate with a cold surface beneath the continental plate should result in a low terrestrial heat flow in the coastal area adjacent to the trench. Nevertheless, many hot and warm springs are known in this zone distributed more o less uniformly from the Tehauntepec isthmus at south (~16°N) to Punta Mita at north (~21°N). Two oceanic plates are subducting beneath the continental North America Plate along the Mexican Pacific coast: Cocos Plate south of Colima graben (~19°N) and a young Rivera Plate to the north of Colima graben. The trench is situated ~ 60 km from the shore line which is close comparing with other continental margins. Chemical and isotopic composition of waters, helium, carbon and nitrogen isotopes in bubbling gases were obtained for 29 groups of thermal springs between 16°N and 21°N, in a ~30 km-wide zone along the coast. Their temperature and salinity ranges are 35-90°C and 100-20,000 ppm, respectively. The observed $^3He/^4He$ ratios were 0.16Ra to 4.5Ra (where $Ra=1.4x10^{-6}$, the air ratio) indicating that some springs discharge gas with a high contribution of mantle helium while the others contain helium of the crustal origin. High $^3He/^4He$ ratios were measured in springs located close to Colima graben, the apparent surface border between Rivera and Cocos plates and also within the Puerto-Vallarta (Rio Ameca) graben at the northernmost part of the coastal forearc zone. The permeability of these areas to the mantle He is interpreted as a margin effect at the northern part of the subduction zone and as a "slab window" in the vicinity and to the south of Colima graben; a discontinuity between subducting plates.

The nitrogen isotopic composition is in a good positive correlation with the N_2/Ar ratios. The highest $\delta^{15}N$ of 4-5‰ were measured for gases with N_2/Ar >300, indicating a presence of non-atmospheric nitrogen of sedimentary origin. These high values are associated with the high-salinity springs which probably connected with the accreted to the continental slope organic-rich sedimentary material.

The geographic distribution of $^3He/^4He$ ratios were used for the first-order estimation of distribution of the heat flow within the studied area. We suggest that for the thermal modeling of the forearc heat flow, the heterogeneity of the heat sources (slab margins and slab discontinuities) should be taken into account. The $^3He/^4He$ distribution can help to constrain the geometry of zones permeable for the mantle heat and volatiles.