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Geochemical evolution of geothermal fluids around the Western Red Sea and East African Rift geothermal provinces

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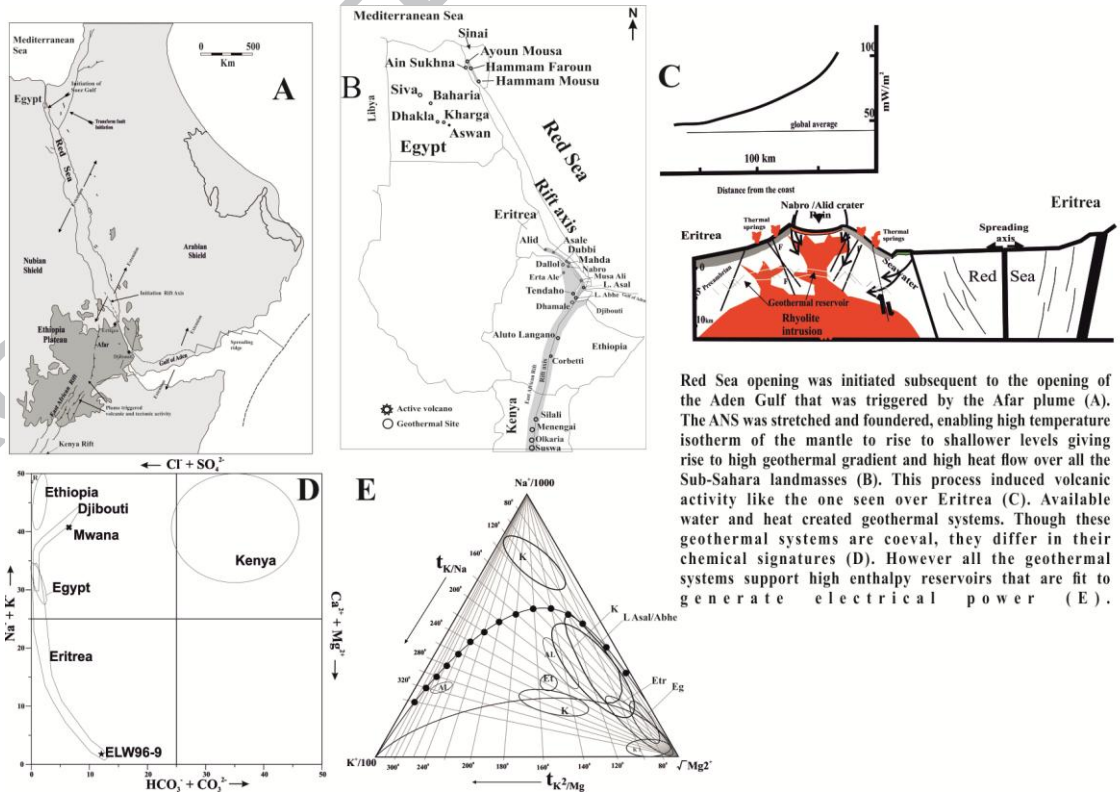
Abstract

The geothermal provinces of the western Red Sea coast and East African countries have evolved synchronous with the evolution of the landmasses around the Red Sea. The Red Sea opening was initiated subsequent to the opening of the Aden Gulf that was triggered by the Afar plume. During the Late Oligocene, the Red Sea rift started extending from south towards north culminating into a failed arm near the Suez Gulf. The geothermal systems evolved due to shallow mantle below the Danakil depression and circulating seawater. Besides the volcanic flows, the regional sedimentary aquifers like the Wajid Sandstone and Amron limestone, that occur in Ethiopia, Egypt, Eritrea and Djibouti, that were deposited prior to the younger tectonic events that started at 31 Ma. are the main geothermal reservoirs in these countries. In contrast, rain surface and evaporated lake water are the main sources for the Kenyan geothermal systems. Although these geothermal fluids show variation in their chemical components due to different recharging sources, all the geothermal systems are of high temperature, capable of generating electricity

Keywords: Sub-Saharan; geothermal; Afar, Danakil, Red Sea rift, ANS

Graphic abstract



Red Sea opening was initiated subsequent to the opening of the Aden Gulf that was triggered by the Afar plume (A). The ANS was stretched and foundered, enabling high temperature isotherm of the mantle to rise to shallower levels giving rise to high geothermal gradient and high heat flow over all the Sub-Sahara landmasses (B). This process induced volcanic activity like the one seen over Eritrea (C). Available water and heat created geothermal systems. Though these geothermal systems are coeval, they differ in their chemical signatures (D). However all the geothermal systems support high enthalpy reservoirs that are fit to generate electrical power (E).