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The complex electric structure of the Precambrian crust of the Gour Oumelalen (Central Hoggar-South of Algeria): From the constitution of Central Gondwana to intra-plate Cenozoic volcanism

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The Tuareg shield is considered to be the assembly by oceanic closures and/or welding along mega-shear zones developed among of about twenty terranes during the Pan-African Orogenesis. This event corresponds to the constitution of central Gondwana. The Gour Oumelalen (GO) is a key region of the Tuareg shield, located at the northeastern part of the Egéré-Aleksod terrane, representing the east boundary of Laouni, Azrou-n-Fad, Tefedest, Egéré-Aleksod (LATEA) metacraton. The studied area is considered to be an Archeozoic-to-Paleoproterozoic crust with adding of Neoproterozoic granitic intrusions and thrusted emplacement of green-schists. It became an active margin during the Pan-African Orogenesis and was thus considered as a Pan-African suture zone (Ounane Shear zone: OSZ) at present, although it was also experienced the Cenozoic intraplate volcanism.

To decipher the deep structure of GO belt, we deployed 33 broadband magnetotelluric (MT) sites at the first time, forming two parallel E-W profiles of about one hundred kilometers long and perpendicular to major geological structures. The resistivity cross-sections from 3-D inversion of MT profiles data reveals a drastic drop in the electrical resistivity of the middle-to-lower crust compared to its upper crust. And several more or less vertical conductive anomalies translate the geologically mapped faults and shear zones, and coincide with the enhanced total magnetic anomalies.

The very conductive middle-to-lower crust (<10 Ω-m) reflects a typical orogenic structure after collapsing. Owing to that the GO belt was deeply evolved in the process of pan-African orogeny and the Cenozoic intra-plate volcanism, we propose here two competitive causes of the middle-to-lower-crustal conductors. The electrically conductive middle-to-lower crust can be purely caused by heat shielding effect, which was formed by underplating probably occurred in the periods of post-collision and/or orogenic collapsing. The underplating rocks can form a heat shield due to their relatively lower thermal conductivity, which may significantly prevent the dissipation of thermal input by Cenozoic intra-plate volcanism and/or local heating by re-activation of mega-shear zones developed in the Pan-African Orogeny. This hypothesis is partly supported by widely distributed post-collisional intrusions at the late period of Pan-African Orogeny. However, we cannot exclude the cause of geofluids (including water and volatiles) at present, which might be generated by the Cenozoic intra-plate volcanism. This hypothesis is consistent with the seismic activity, even if it is moderate, observed in the Central Hoggar. To determine the origin of electrically conductive middle-to-lower crust in GO belt, we must know more physical properties, e.g., heat flow and seismic velocity, etc., of the entire continental lithosphere.

Keywords: Pan-African orogenesis, Gour Oumelalen belt, Magnetotelluric, electrically conductive middle-to-lower crust, intra-plate volcanism.