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Repeated granitoid intrusions during the Neoproterozoic along the western boundary of the Saharan metacraton, Eastern Hoggar, Tuareg shield, Algeria: An AMS and U–Pb zircon age study

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ABSTRACT

The N–S oriented Raghane shear zone (8°30′) delineates the western boundary of the Saharan metacraton and is, with the 4°50′ shear zone, the most important shear zone in the Tuareg shield. It can be followed on 1000 km in the basement from southern Aïr, Niger to NE Hoggar, Algeria. Large subhorizontal movements have occurred during the Pan-African orogeny and several groups of granitoids intruded during the Neoproterozoic. We report U–Pb zircon datings (laser ICP-MS) showing that three magmatic suites of granitoids emplaced close to the Raghane shear zone at c. 790 Ma, c. 590 and c. 550 Ma. A comprehensive and detailed (158 sites, more than 1000 cores) magnetic fabric study was performed on 8 plutons belonging to the three magmatic suites and distributed on 200 km along the Raghane shear zone. The main minerals in all the target plutons do not show visible preferential magmatic orientation except in narrow shear zones. The AMS study shows that all plutons have a magnetic lineation and foliation compatible with the deformed zones that are zones deformed lately in post-solidus conditions. These structures are related to the nearby mega-shear zones, the Raghane shear zone for most of them. The old c. 793 Ma Touffok granite preserved locally its original structures. The magnetic structures of the c. 593 Ma Ohergehem pluton, intruded in the Aouzegueur terrane, are related to thrust structures generated by the Raghane shear zone while it is not the case of the contemporaneous plutons in the Assodé–Issalane terrane whose structures are only related to the subvertical shear zones. Finally, the c. 550 Ma granite group has magnetic structure related to the N–S oriented Raghane shear zone and its associated NNE-SSW structures when close to them, but NW-SE oriented when further. These NW-SE oriented structures appear to be characteristic of the late Neoproterozoic evolution of the Saharan metacraton and are in relation to the convergence with the Murzuq craton. This evolution reflects the rheological contrast existing along the Raghane shear zone marking the western boundary of the Saharan metacraton.

1. Introduction

The Saharan metacraton (Abdelsalam et al., 2002), although corresponding to the eastern half of Sahara, is still largely unknown (Kilian, 1935; Lelubre, 1952; Guérangé and Vialon, 1960; Bertrand et al., 1978). Its western boundary is delimited by the Raghane shear zone (Liégeois et al., 1994), N–S oriented along the 8°30′ longitude and outcropping on 1000 km from the Aïr mountains in Niger to NE Hoggar in Algeria. To the East, the Aouzegueur, Barghot, Edembo and Djanet terranes (Black et al., 1994) belong to the Saharan metacraton but generally present its young superstructures. Their Algerian parts belong to the Eastern Hoggar, whose particularities compared to Central Hoggar have long been recognized (Bertrand and Caby, 1978). The Assodé–Issalane terrane is part of Central Hoggar, is located to the West of the Raghane shear zone and is characterized by a Pan-African high-temperature amphibolite facies metamorphism accompanied by a regional partial melting exemplified by the Renatt leucogranite and migmatites (Liégeois et al., 1994).

The main magmatic event along the Raghane shear zone occurred in the 620–580 Ma interval (Bertrand et al., 1986; Liégeois et al., 1994). Until very recently, it was considered that the Eastern Hoggar, i.e. the Hoggar part east of the Raghane shear zone, was stabilized early at

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c. 730 Ma, the age of an undeformed granite pluton considered as late to post-orogenic (Caby and Andreopoulos-Renaud, 1987). Current research shows that the Eastern Hoggar was actually stabilized later than the rest of Hoggar, namely at 575–545 Ma, this period including both the intrusion of granitoids and regional metamorphism (Fezaa et al., submitted for publication).

A series of batholiths and plutons intruded along the Raghane shear zone. In the field they are mostly undeformed, the deformation being localized in narrow shear zones (Liégeois et al., 1994). The main easily visible effect is the elongated shape of the intrusive bodies parallel to the Raghane shear zone but this is not the case for all plutons, some of them being roughly circular. Knowing the existence in the area of granitoids of several ages at 730 Ma, 620–580 Ma and 575–545 Ma (Bertrand et al., 1986; Caby and Andreopoulos-Renaud, 1987; Liégeois et al., 1994; Fezaa et al., submitted for publication) and even 800–820 Ma (Liégeois et al., 2005), we undertook a study of the Anisotropy of Magnetic Susceptibility (AMS — e.g. King, 1966; Hrouda et al., 1971; Henry, 1974; Djouadi and Bouchez, 1992; Archanjo et al., 1994; Borradaile and Kehlenbeck, 1996; Pignotta and Benn, 1999; Bouchez, 2000; Tomezzoli et al., 2003; Henry et al., 2004; Auréjac et al., 2004; Kratinová et al., 2007). We applied this structural method to eight undeformed plutons located along the Raghane shear zone for a better understanding of their emplacement relative to the contemporaneous tectonic stress. To reach such a goal requires dating of some representative plutons, which has been done on three of them (U–Pb laser ablation ICP-MS on zircon). The studied plutons belonging to three different stages (c. 790 Ma, c. 590 and c. 550 Ma), the study of their AMS aims at deciphering the complex interplay of the successive tectonic stresses registered by nearly strain-free plutons that occurred along a same mega shear-zone. In addition, this study provides information about the behavior of the western margin of the Saharan metacraton during the Neoproterozoic.

2. Geological setting

2.1. The Tuareg shield

The Tuareg shield (Fig. 1) is composed of 23 terranes Archaean to Neoproterozoic in age, juxtaposed after large displacements along mega-shear zones (Black et al., 1994; Liégeois et al., 1994). Most of these

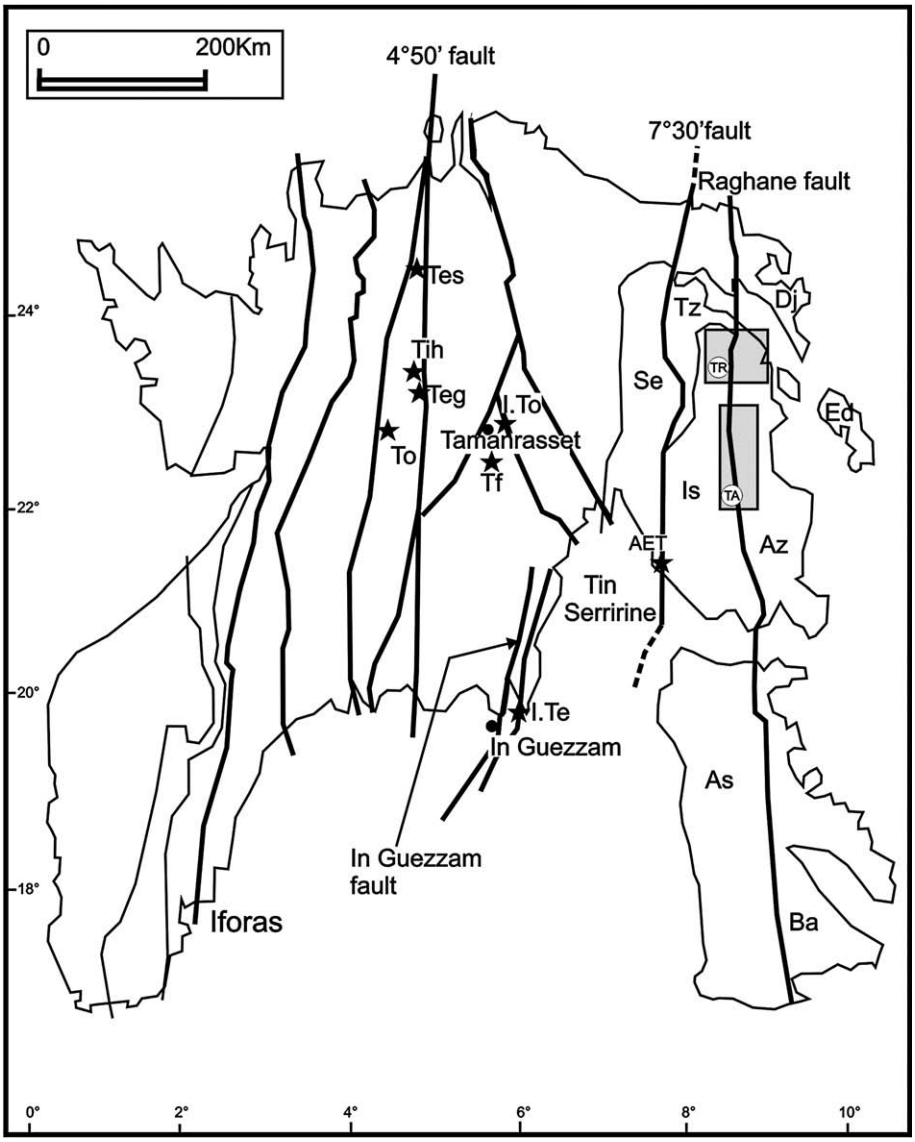

Fig. 1. General geological sketch map of the Tuareg shield showing the studied Late Panafrican plutons. Terranes of Assodé (*As*), Issalane (*Is*), Tazat (*Tz*), Aouzegueur (*Az*), Barghot (*Ba*), Djanet (*Dj*) and Edembo (*Ed*). Tihaliouine (Tih — Henry et al., 2008), Teg Orak (Teg — Henry et al., 2008), Tesnou (Tes — Djouadi and Bouchez, 1992), Alous En Tides (AET — Henry et al., 2004), In Telloukh (ITe — Henry et al., 2007), Tioueine (To — Djouadi et al., 1997), Tifferkit (Tf — Henry et al., 2006) and In Tounine (Ito — Henry et al., 2006) plutons. Tadoumet (TA) and Tiririne (TR) areas.