Metallogenic implications of a new geodynamic model for the Eglab, Algeria

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The Reguibat Shield is the northern part of the Archean-Proterozoic West African Craton. The Algerian portion of the Reguibat Shield is an extensive (~125,000 km^2), long-lived Paleoproterozoic volcanic-plutonic tract. Previous workers (e.g., Lasserre et al., 1970; Sabate, 1973) have subdivided this basement into the Yetti domain to the west and the Eglab domain to the east, separated by a postulated terrane boundary called the "Yetti-Eglab shear zone." Our Algerian Geological Survey Agency (ASGA) – U.S. Geological Survey (USGS) study area includes these domains and is known as the Eglab region. Magmatism in the Eglab region spanned more than 150 million years of Paleoproterozoic time during the Birimian (or Eburnian; ca. 2250-1900 Ma; Peucat et al., 2005) orogeny. Latest Birimian to possibly Mesoproterozoic dikes were the last major event in the region until onset of the Neoproterozoic Pan-African orogeny, which resulted in deformation in the Eglab region in the form of faulting and folding but little magmatism and no metamorphism. The youngest widespread magmatic event recorded in the Eglab region was the emplacement of Central Atlantic Magmatic Province (CAMP) mafic dikes and sills at ca. 200 Ma. Within the study area, the Tindouf (Cambrian or Ordovician to Devonian), Reggane (probably late Mesoproterozoic to Devonian), and Taoudeni (Mesoproterozoic to Cambrian or Ordovician) basins form the margins of the Eglab region on the north, east, and south flanks, respectively.

The most widely accepted tectonic model for the Eglab region (Peucat et al., 2005) proposes that a 2.73 Ga relict of oceanic crust formed a cratonal core against which an eastward-dipping subduction zone developed, producing arc magmatism in the Eglab domain from 2.21-2.18 Ga. Closure of an intervening ocean and collision of the Yetti and Eglab domains at 2.09 Ga produced a second active margin magmatic event and deformation along the supposed Yetti-Eglab terrane boundary. Both domains were then intruded by large volumes of high-K, post-orogenic magmas triggered by slab roll-back and asthenospheric upwelling.

Our work defines magmatic episodes at about 2210, 2150, 2090, and 2075 Ma. From ca. 2240 to 2100 Ma, magmatism was the product of east-dipping subduction, with the axis of magmatism migrating from east to west. The composite Paleoproterozoic arcs collided with the Archean craton in Mauritania at ca. 2090 Ma. The Paleoproterozoic Yetti, Akilet Deilel, and Oued Souss basins are intra-arc basins comprising continentally derived sedimentary rocks and dacite-rhyolite volcanic rocks. Oceanic sedimentary and basaltic volcanic rocks are rare to absent. Similarity of detrital zircon age populations and composition suggests absence of a major terrane boundary along the postulated Yetti-Eglab shear zone. Late collisional slab break-off resulted in a voluminous post-collisional igneous flareup and emplacement of early high-K calc-alkaline and later alkaline magmas throughout the Reguibat Shield at 2080-2060 Ma. Our preferred model for the geodynamic evolution of the Eglab region is shown in Figure 1.

Our field observations, as well as igneous and detrital zircon geochronologic studies, do not support the presence of an Archean continental nucleus in the Eglab region. The absence of a significant Archean remnant in the Eglab region is also shown by neodymium model ages (T_{DM}, "mantle separation ages", 2.5 to 2.2 Ga; Peucat et al., 2005) that decrease from east to west, consistent with our igneous zircon data. All igneous rocks are overwhelmingly calc-alkaline, suggesting formation in an arc-subduction zone environment—probably as a series of continental margin arcs. The majority of the intrusive rocks are mixtures of metaluminous to peraluminous (I- and S-type) granites with a minor component of alkaline rocks; few igneous rocks exhibit A-type or peralkaline compositions, i.e., they are post-collision granites, not within-plate granites.

Geophysical data do not show the presence of a major terrane boundary along the postulated Yetti-Eglab shear zone. The observed magnetic low over the Yetti granitic rocks is likely due to lower magnetite content in rocks with a higher component of metasedimentary protolith. This is supported by the slightly more peraluminous character of the Yetti basement compared to the Eglab basement.

Based on our tectonic and metallogenic interpretations of the new data, a wide variety of mineral deposit types are permissible to occur in the Eglab. The most likely deposits include Mo-Cu porphyry deposits in arc magmatic rocks, epithermal base and precious metal vein deposits related to porphyry intrusions, and orogenic Au and Cu-Mo vein deposits in the Birimian volcano-sedimentary sequences. Also likely are U-Th-Nb-Ta-REE and possibly Au deposits related to alkaline/peralkaline granites, granite-hosted (shear) and calcrete-hosted (Hamada-type) uranium deposits, and Phanerozoic oolitic ironstones. Deposit types that are permissive, but less likely to occur, include PGE-Cr in layered gabbroic intrusions (sulfide-poor reef-type), Cu-Ni-PGE in unlayered mafic-ultramafic dikes/sills (sulfide-rich conduit-type), and iron/magnetite skarn and sedimentary rock-hosted U and Cu deposits in the marginal basins flanking the Eglab.

The absence of a thick cratonic core in the Eglab region has important implications for diamond exploration. Previous studies have suggested that the Eglab may be a source region for headless diamond placers in Reggane, and several studies have noted the presence of a few harzburgitic “G9” and eclogitic garnets (Zerrouki, 2000; Kahoui et al., 2008). During the ASGA-USGS project, 74 regolith samples were collected and processed for kimberlite indicator minerals. Electron microprobe data for ~800 garnets were evaluated using the classification scheme of Schulze (2003). Our samples contained no peridotitic garnets; however, 74 eclogitic and 3 Cr-poor megacrystic garnets were detected. The majority of the eclogitic garnets are “group B”-type; of the remainder, a few are “group-C”-type and grospydite garnets. While eclogitic garnets are not as prospective for diamond potential as the presence of peridotitic garnets, the Eglab region remains permissive for primary diamonds in “off-craton” kimberlite.

Keywords: Reguibat Shield, Eglab, Birimian, magmatic episodes, geodynamic model, mineral deposits, diamond.

References

Kahoui, M., Mahdjoub, M., Kaminsky, F.V., 2008. Possible primary source of diamond in the north African diamondiferous province. In Ennih, N. & Liegeois, J.P. (Eds). The boundary of the west African craton. *Geological Society London*, Special Publications, 297, 77-109.

Lasserre, M., Lameyre, J., Buffière, J.-M., 1970. Données géochronologiques sur l’axe précambrien Yetti-Eglab en Algérie et en Mauritanie du Nord. Bull. *B.R.G.M.*, IV, 5-13.

Peucat, J.-J., Capdevila, R., Drareni, A., Mahdjoub, Y., Kahoui, M., 2005. The Eglab massif in the West African Craton (Algeria), an original segment of the Eburnean orogenic belt: petrology, geochemistry and geochronology. *Precambrian Research*, 36, 309-352.

Sabaté, P., 1973. La jointure Yetti-Eglab dans la dorsale précambrienne du pays Reguibat (Sahara occidental algérien). *C. R. Acad. Sci. Paris*, 276, 2237-2239.

Schulze, D.J., 2003. A classification scheme for mantle-derived garnets in kimberlite: A tool for investigating the mantle and exploring for diamonds. *Lithos*, 71, 195-213.

Zerrouki, A., 2000. Géologie et minéralisations du massif Eglab. *Rapport inédit ORGM*.

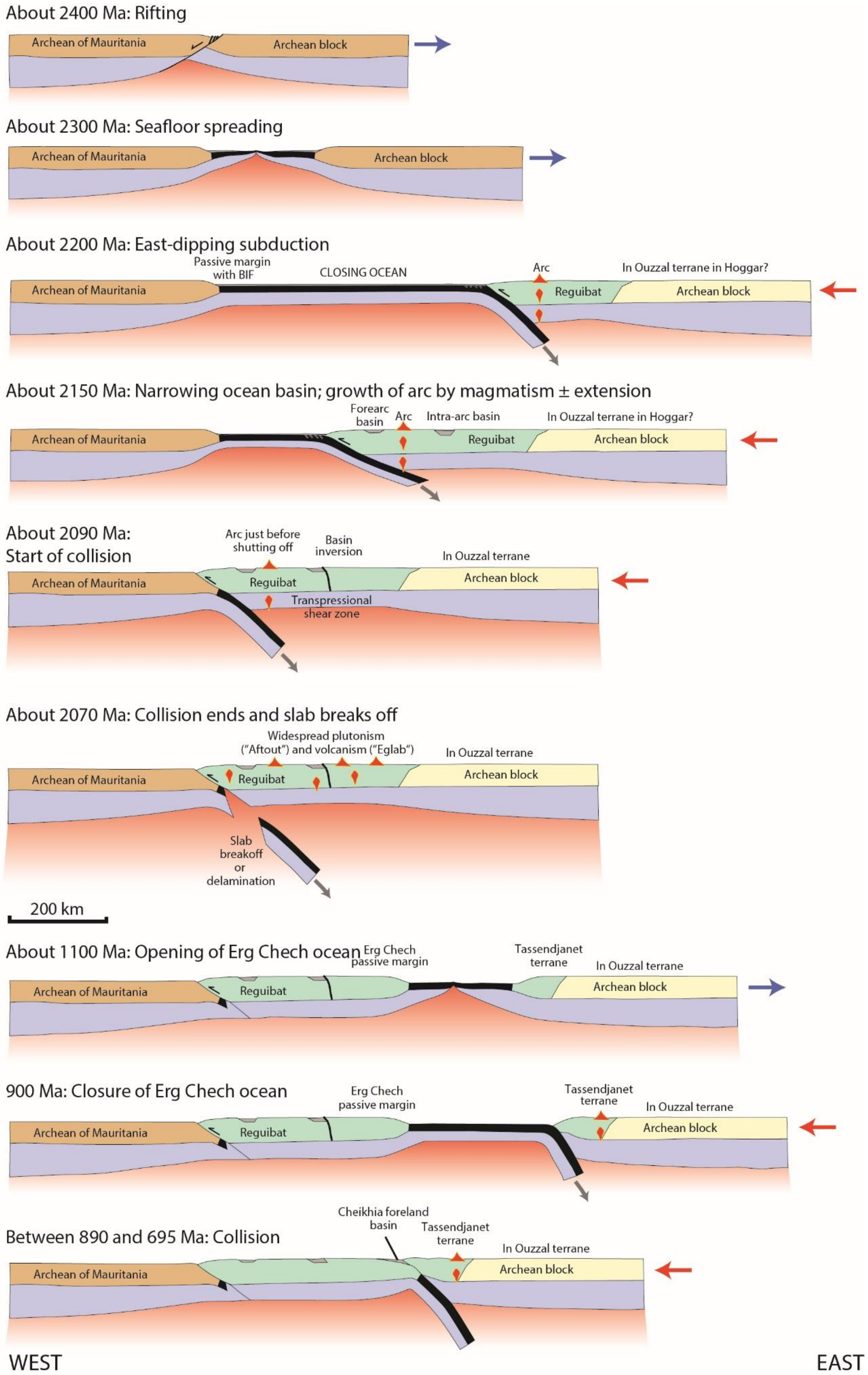

Figure 1. New ASGA-USGS model for the geodynamic evolution of the Paleoproterozoic Reguibat Shield. BIF = banded iron formation.