Ore Geology Reviews 101 (2018) 609–628

Contents lists available at ScienceDirect

Ore Geology Reviews

journal homepage: www.elsevier.com/locate/oregeorev

The rare metal deposits of the El Garra El Hamra syenites, South Western Desert, Egypt

Soliman Abu Elatta A. Mahmoud[a,*], Anthony E. Williams-Jones[b]

[a] Nuclear Materials Authority, Cairo, Egypt
[b] Department of Earth and Planetary Sciences, McGill University, Montreal, QC, Canada

ARTICLE INFO

Keywords:
El Garra El Hamra
Guinean-Nubian lineament
Peralkaline
Trans-African shear zone
REE

ABSTRACT

The El Garra El Hamra complex is a small high-level plug (with associated volcanics) that was emplaced along an ENE-WSW trending dextral strike-slip fault corresponding to the Guinean-Nubian lineament. Owing to continued movement along this fault, the intrusion split into two parts that were displaced horizontally by approximately 580 m. The intrusion consists mainly of syenites (fresh and altered) and granites (altered) that are locally overlain by alkaline trachyte and rhyolite and are hosted by Nubian sandstones. The fresh syenites are composed of perthitic K-feldspars, albite, alkali pyroxenes (aegirine-augite and aegirine) and secondary alkali amphiboles (arfvedsonite and riebeckite). Accessory minerals include opaques, apatite, zircon, xenotime-(Y) and bastnäsite-(Ce). Calcite and hematite are alteration products. Geochemically, the syenites are peralkaline; their CIPW norms classify them as ranging between syenite and quartz syenite in compositions. They were emplaced in a within-plate tectonic setting along the Guinean-Nubian lineament (Kalabsha), close to the extension of the Chephren-Kom Ombo trend (a branch of the Trans-African Shear Zone). They were evolved from a magma compositionally similar to Ocean island basalt (OIB). Numerous dextral and sinistral strike-slip faults cut the intrusion and may have facilitated the circulation of fluids that altered them hydrothermally. These faults developed during or shortly after emplacement of the intrusion or perhaps during subsequent reactivation of the Guinean-Nubian and Trans-African shear zones and were accompanied by dykes that range in compositions from intermediate to acidic composition; most of which strike ENE-WSW. Hydrothermal alteration of the syenites locally led to extreme enrichment in rare metals (e.g. LREE, HREE, Zr, Hf, Th, U, Nb and Be) as the minerals zircon, gittinsite, bastnäsite-(Ce), parisite-(Ce), monazite–(Ce), REE-rich fluorapatite, chevkinite-(Ce), xenotime-(Y), pyrochlore, columbite-(Fe), Nb-rutile and thorite. Fluorite and barite are important gangue minerals.

1. Introduction

The rare metal province of South Western Egypt is associated with altered peralkaline rocks localized along the eastern extension zone of the Central African lineament and the Trans-African lineament (Shandelmeier and Pudlo, 1990). Black et al. (1985) and Bowden (1985) concluded that the alkaline provinces in North Africa (including that discussed here) are related to major weaknesses in the lithosphere represented by these two megashears and related Riedel faults (Fig. 1a). Hashad and El Reedy (1979), Serencits et al. (1979) and Abu Elatta et al. (2013), concluded that in Egypt emplacement of peralkaline rocks along the ENE-WSW trending of the Guinean-Nubian lineament and the NNW-SSE trending of The Trans-African shear zone were associated with the rifting and the opening of the Atlantic Ocean and the Red Sea. The Trans-African shear zone, which extends from the Niger Delta in Nigeria to the Nile delta in Egypt (Nagy et al., 1976) (Fig. 1a), has been active since the Jurassic and was particularly active during the Late Mesozoic when peralkaline rocks were interpreted to have been emplaced. The most important branches of the Trans-African shear zone in Egypt are Uweinat-Baharia-Port Said trend, Tarfwai-Qena South Sinai trend and Chephren-Kom Ombo trend (Issawi et al., 2009) (Fig. 1c). In addition, there is another dextral trend related also to the Equatorial Atlantic fractures, which extends from Gulf of Guinea to the Red Sea in South of Egypt (Guiraud et al., 1985, 2000; Fig. 1b). This trend is called the Guinean-Nubian lineaments (Fig. 1b and c) and the most important branch of this lineament in Egypt is Kalabsha fault (Issawi, 1968; Issawi et al., 2009) (Fig. 1c). The Guinean-Nubian lineament has been reactive until very recent times; e.g., in 1983, an earthquake took place along the Kalabsha fault.

El Garra El Hamra (Fig. 2) is one of a small number of peralkaline

* Corresponding author.
E-mail address: dr.soliman72@yahoo.com (S.A.E.A. Mahmoud).

https://doi.org/10.1016/j.oregeorev.2018.08.001
Received 16 April 2018; Received in revised form 17 July 2018; Accepted 1 August 2018
Available online 02 August 2018
0169-1368/ Published by Elsevier B.V.

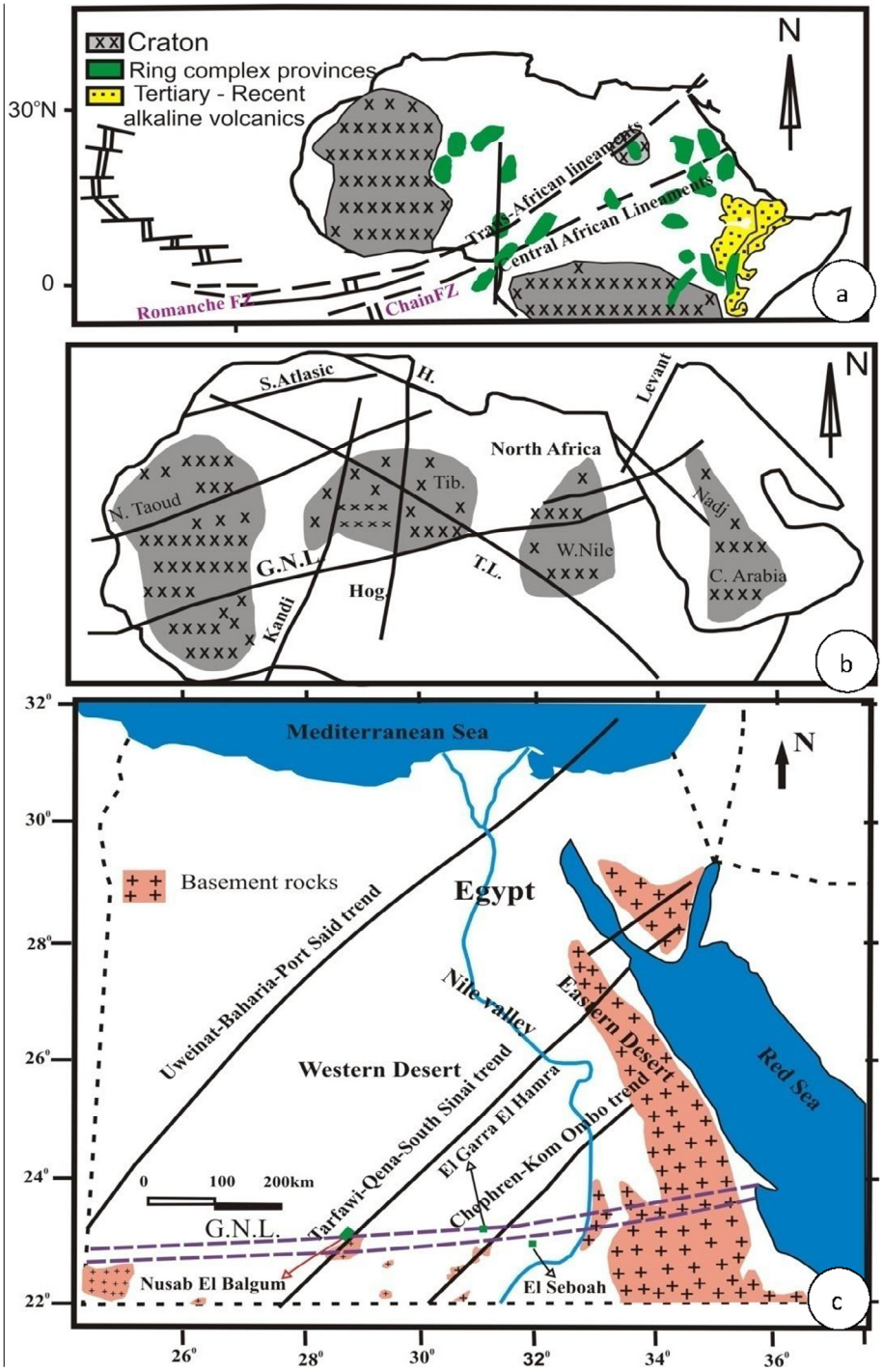

Fig. 1. a-Compiled geologic map (after Nagy et al. (1976), Black et al. (1985), Bowden (1985), Shandelmeier and Pudlo (1990)) showing the distribution of alkaline provinces in North Africa and its relation with major shear zones, b-Major shear zones and apparent Archean and Paleoproterozoic cartons from Guiraud et al. (2000), (G.N.L., Guinean–Nubian lineament; H, Hodna; Hog, Hoggar; N Taoud, North Taoudenni Lineament; Tib, Tibesti; T. L., Tibesti Lineament. Apparent curvature of the Tibesti Lineament is due to projection) and c-Location of the studied area, major trends of the trans-African shear zone and the Guinean Nubian lineament in Egypt (Nagy et al., 1976; Issawi et al., 2009).

intrusions that are exposed in Southwestern Egypt. However, it is very likely than others lie hidden beneath late Cretaceous Nubian sandstones, based on the occurrence of numerous dykes of peralkaline composition, which cut the Nubian sandstone in areas where large intrusions have not been observed (e.g., El Seboah; Abu Elatta et al., 2014).

The El Garra El Hamra complex comprises peralkaline volcanics (peralkaline rhyolite and trachyte) and intrusions (peralkaline granites and syenites) (Issawi, 1968; Fig. 2a). The latter was emplaced in Nubian sandstones. Although the age of the complex is unknown, the host rocks and the occurrence of numerous xenoliths of Nubian sandstones in the complex are constrained to be no older than late Cretaceous age (Hegazy, 2009). Three periods of peralkaline igneous activity have been recognized in Southern Egypt, namely at 250–200 Ma, 155–125 Ma, and 110–70 Ma (El Reedy, 1979; El Sayed et al., 2014). We, therefore, conclude that El Garra El Hamra was emplaced during the youngest of these periods; the late Cretaceous is defined by the International Commission on Stratigraphy as the time interval 100.5–66 Ma (International Commission on Stratigraphy, 2015).

Locally, the El Carra El Hamra complex hosts high concentrations of rare metals (e.g., Th, U, Zr, Hf and Nb) and is of particular interest because of its concentration of rare earth elements (REE) and the high proportion of heavy REE (HREE) relative to light REE (LREE). The purpose of this article is to present information on the primary nature of the syenites, their hydrothermal alteration and related rare metal mineralization and on the major-and trace element geochemistry of the