Journal of African Earth Sciences 57 (2010) 163–168

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

Pillow form morphology of selected Neoproterozoic metavolcanics in the Egyptian Central Eastern Desert and their implications

E.S. Farahat [a,*], M.M. El Mahallawi [a], G. Hoinkes [b], A.Y. Abdel Aal [a], C.A. Hauzenberger [b]

[a] Department of Geology, Minia University, El-Minia 61519, Egypt
[b] Institute of Mineralogy and Petrology, Karl-Franzens University, Graz, Austria

ARTICLE INFO

Article history:
Received 9 September 2008
Received in revised form 26 August 2009
Accepted 1 September 2009
Available online 6 September 2009

Keywords:
Arabian–Nubian shield
Ophiolites
Metavolcanics
Pillow forms
Egypt

ABSTRACT

This study discusses the features of well-preserved pillow forms of seven Neoproterozoic metavolcanic occurrences found in the Central Eastern Desert of Egypt and compares them to modern and ancient tectonic environments. The aim is to present a mode of origin model, parent magma composition and eruption environment of these lavas.

Categorized on size and shape, three different pillow types have been recognized: elongated pillows (type A), in the Muweilih and Wadi Beririq; bulbous pillows (type B) in Wadi Ghadir, Gabal Ghadir and Wadi Um Seleimat; and spherical pillows (type C) in Wadi Kareim and Gabal Semna.

Absent in the studied pillow forms are the tubular type pillow, connection between pillows, and radial crack features. The most prominent features of the studied pillows are flattening, tight packing with development of chilled margins, small size, and the abundance of vesicular structure. These features indicate their accumulation at high initial temperature and hydrostatic pressure, low viscosity, and rapid eruption when compared to modern mid-oceanic ridge pillows.

The significant features of the studied pillow forms show they differ from pillows of the modern mid-oceanic ridge environments, and are akin to pillows found in ancient marginal basin environments (especially types A and B). The small size of type C pillows is considered a by-product of the felsic composition, which suggests formation in an island-arc environment. The deduced paleotectonic environments are supported by geochemical data and the resulting regional implication is that the central part of the Eastern Desert of Egypt could represent a SE subducted arc-back-arc system.

1. Introduction

Basement rocks crop out around the Red Sea in the Arabian Peninsula, Sinai, Eastern Desert of Egypt, Red Sea Hills of Sudan, Eritrea and far south to Ethiopia constitute the Arabian–Nubian Shield (ANS) (Fig. 1). This shield was cratonized during the Neoproterozoic Pan-African orogeny by convergent plate margin processes found in modern plate tectonics (Stern, 2002; Hargrove et al., 2006).

Basement rocks in the Eastern Desert of Egypt are divided by two major shear zones into three, lithologically distinguished, domains (Fig. 1): North Eastern Desert (NED), Central Eastern Desert (CED) and Southern Eastern Desert (SED) (Stern and Hedge, 1985; El Gaby et al., 1988). Metavolcanic rocks cover large areas in the CED and SED, but are rarely present in the NED (El Gaby, 1994). These rocks form the upper part of commonly dismembered ophiolitic successions in several localities, or as individual fragments in the widespread Eastern Desert ophiolitic mélange. They also constitute the main part of the associated mafic to felsic metavolcanic rocks of island-arc environments. The available geochemical data indicate that the ophiolitic metavolcanics are of supra-subduction origin. However, no ophiolite complex with a true MORB trace element signature has yet been identified (Berhe, 1990).

The pillow forms of some metavolcanic rocks from the Eastern Desert of Egypt are well-preserved, providing an opportunity to study their primary features. This work provides a comparative morphological study of seven pillow metavolcanic occurrences from the CED and assesses their use to interpret the mode of origin and environment of eruption. The inferred paleotectonic settings using pillow morphologies are reinforced geochemically and their regional implications are briefly discussed.

* Corresponding author. Tel.: +20 86 2378500; fax: +20 86 2363011.
E-mail address: esamfarahat1@yahoo.com (E.S. Farahat).

1464-343X/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jafrearsci.2009.09.001

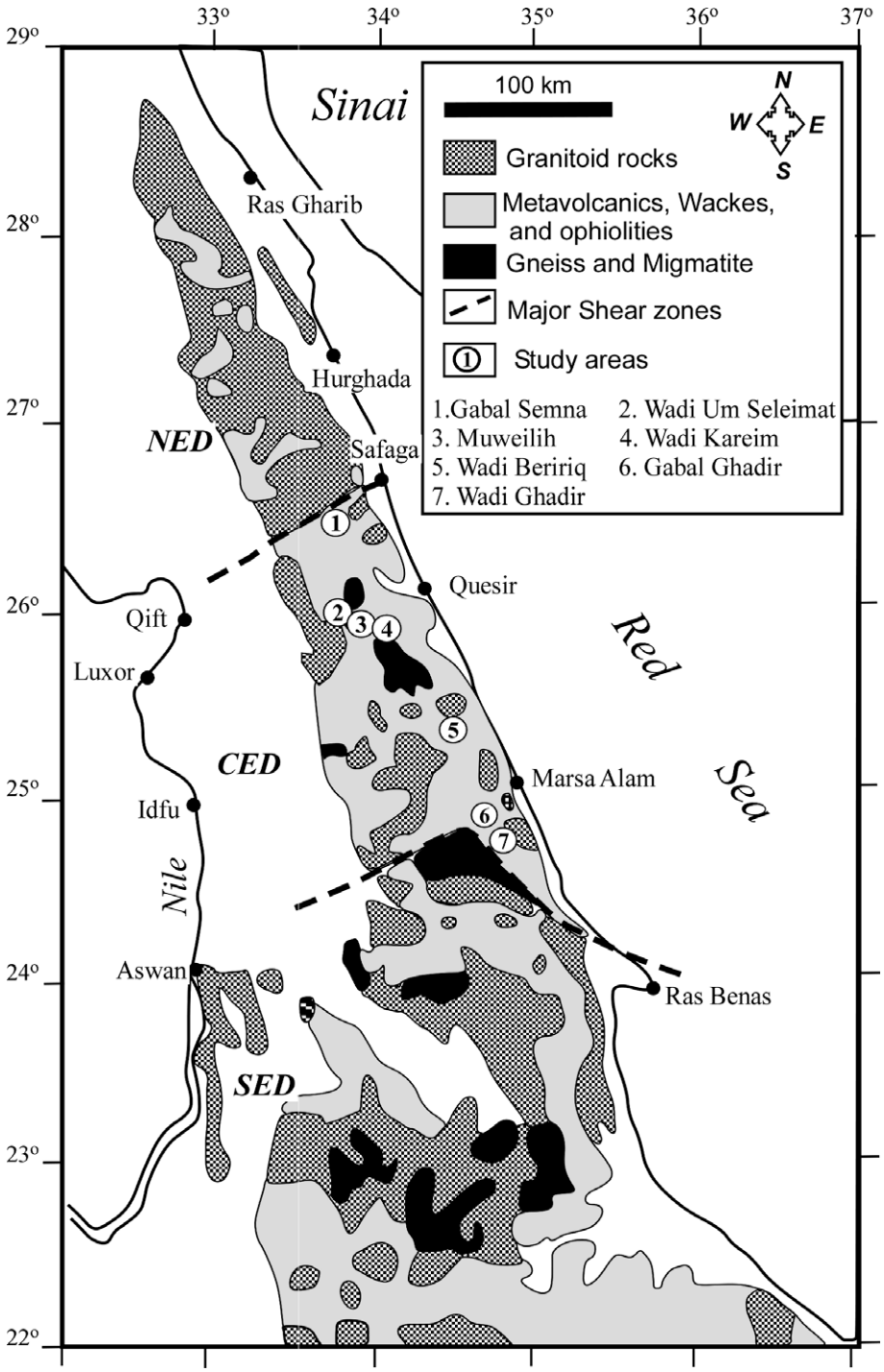

Fig. 1. Simplified geologic map of the Eastern Desert of Egypt with distribution of the major Neoproterozoic Pan-African basement units and sample localities (modified from Stern and Hedge, 1985). The two major shear zones separating north Eastern Desert (NED), Central Eastern Desert (CED) and South Eastern Desert (SED).

2. Investigated metavolcanic occurrences

The seven metavolcanic occurrences (Fig. 1) are:

2.1. Gabal Semna

These pillow metavolcanics occur as dismembered masses elongated E–W along the southern bank of Wadi Semna and its tributary Wadi Abu Qarahish. These rocks consist mainly of tholeiitic metabasalts and metabasaltic andesite, together with subordinate meta-andesite and metarhydacite.

2.2. Wadi Um Seleimat

The ophiolite units in this area seem to be intact. The succession comprises (from bottom to top), serpentinized harzburgite, pyroxenite, metagabbro, massive diabase and pillow metabasalt. The latter is mainly andesitic basalts with tholeiitic affinity. Few samples from this region display boninitic signature.