Pan African mafic-ultramafic cumulate intrusions
SW Sinai massif: mineralogy, geochemistry and
crustal growth

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Late Proterozoic mafic-ultramafic cumulates were
intruded toward the end of the Pan African event
(950–550 Ma). The rocks constitute cyclic units of
repeated sequence: wehrlite, clinopyroxenites and
gabbros, locally crossed by the dyke-like bodies of
anorhostites and trondhjemites. Crystal fractiona-
tion appears to have occurred in an open system,
where the cumulates involve the following
cumulus assemblages, in sequences of increasing
fractionation: (i) ol + opx + cpx + cr-spin, (ii)
ol + cpx + cr-spin, (iii) ol + plag + cpx ± Hbl,
(iv) plag + Hbl, (v) plag. Cryptic and phase
layering indicate at least five to eight stratigraphic
regressions to higher temperature assemblages.
These regressions are interpreted as reflecting
periodic replenishment of the magma chamber
with fresh melt. Each batch of fresh melt is
apparently mixed with the differentiated residue
of the previous batch. The large reciprocal
variations of Cr and Al in chromian-spinel and
the strong correlation of increasing cr-number and
decreasing mg-number, reflected a high degree of
partial melting of an undepleted continental
mantle source region. The peridotites and
gabbros contain intercumulus
and cumulus hornblende respectively, which is
rich in K₂O (0.2–0.7 wt%) with TiO₂/K₂O ratio
varing between 2 and 2 respectively. The hydrous,
K₂O-rich and TiO₂-poor nature of the peridotite
magma might be due to addition of fluids to the
mantle material before and/or during partial
melting. The source of these fluids is attributed
to a subducted slab. The mafic-ultramafic rocks of
SW Sinai could therefore be considered as relic
diapir generated above the subducted slab and
ascended through the mantle wedge.

Introduction

The Egyptian Shield of Eastern Desert and
southern Siani formed during the Pan African
orogenic episode (sensu lato; 950–550 Ma) by
initiation, maturation and amalgamation of island
arc terrains - a similar scenario to that in Arabain
Shield (Stern et al., 1989). Vail (1988) envisaged
massive intrusions of late to post tectonic granites,
thrusting, strike-slip faulting and dykes emplace-
during the final stage of the evolution
process (650–500 Ma). The late- to post- orogenic
ultramafic-mafic cumulates in concern, were
intruded into the southern Sinai segment during
the third episode (640–550 Ma) of crustal growth
of the Sinai massif (Essawy and El-Metwally,

This work specifically concerns the mineralo-
gical and geochemical evidences of the generation
and evolution of mantle derived melt of the late to
post orogenic ultramafic-mafic intrusions from
the south-western Sinai massif. To achieve that 62
samples were chemically analysed by XRF and 25
samples were analysed by microprobe micro-
analyser.

Petrography

The fractional crystallization in the mafic-ultra-
mafic cumulates appears to have envolved the
following cumulus assemblages (in sequence of increasing
fractionation): (i) ol + opx + cpx + chr. spin +
cpx, (ii) ol + cpx + chr-spin, (iii) ol + plag + cpx ± Hbl,
(iv) plag + Hbl, (v) plag. The cumulate
textures vary from orthocumulates, mesocumu-
lates to adcumulates. In the cumulate rocks,
features such as tabular (plagioclase) lamination,
rhythmic layering, isomodal accumulation and
current laminations are locally well developed.

Mineral chemistry and geochemistry

The chemistry of the chromian-spinel of perido-
tites reveals (Fig. 1) affinities similar to that of the
layered intrusions (Dick and Bullen, 1984). The
chromian-spinel shows: cr-number 100Cr/(Cr +
Al) mostly more than 60 and mg-number (100
Mg/(Mg + Fe2*)) less than 60. Olivines vary in
composition from fo86.8 to fo93.5. Hypersthene has
average of wo4.6 en48 fs47.4 and diopside has
average of wo47.1 en44.2 fs9.4. Ca-plagioclase has
an average composition of An91–45. In terms of
TiO₂-K₂O contents in magnesio-hornblendes of
Fig. 1. Composition of chromian-spinel in ultramafic cumulates in terms of 100 Cr/(Cr + Al) versus 100 Mg/(Mg + Fe2+) and discrimination fields are after Dick and Bullen (1984). Crosses denote wehrlites and opened circles indicate clinopyroxenites.

Fig. 2. TiO2 versus K2O contents of hornblende in clinopyroxenites (o) and gabbros (o). The range of TiO2/K2O ratio for primitive basalts are after Ozawa (1988): BAB = back-arc basin; NMORB, EMORB = N-type and E-type mid oceanic ridge basalts; OIPB = Oceanic intraplate basalt; CFB + CRB + CAB = Continental flood basalt, continental rift basalt and other continentalbasalt; IAB = Island arc basalt; HMA = high magnesian andesite; KIMP Kimbelite and LAMP = Lamporite.

Elements in ultramafic varieties is consistent with the adcumulate nature of these rocks.

References