

belongs to the belt bordering the South Armorican Shear Zone (S.A.S.Z.). The purpose of this work is to understand the relations between the magma's ascent and the regional deformation, the timing of metamorphic and tectonic events and the global P-T conditions during the emplacement of the pluton.

The geological surroundings of this granite are trondhjemite, metadolerite dykes, quartz veins and mesozonal brioverian metasediments (micaschists). These last are characterized by an E-W schistosity S_1 , subparallel to the pluton's limits and to the axial plane of large scale symmetric folds. This metamorphic cleavage bears a subhorizontal mineral lineation L_1 , parallel to the foliation's direction and to the folds' axis. The pluton itself shows a cartographic E-W stretched dissymmetric ellipse owing to the interference between the magma's ascent and the regional strain. Indeed, the internal structure of the granite (the magmatic foliation), showing a clear warping toward the North, is underlined by several shear zones (N100°E-N110°E) parallel to the S.A.S.Z. So, the parallelism between S_1 and the internal structure of the granite, the geometrical continuity between these structures getting through the pluton's limits as well as the elongated shape of the pluton prove that the emplacement is related to a *synkinematic* and *synmetamorphic ascent* during a tectono-metamorphic stage marked by ductile *trascurrent shears*.

Several thin sections realized near and far the granite, have shown two main metamorphic minerals: phorphyroblasts of *staurolite* coexisting with *andalusite*. These minerals can be ante-, syn- or post- S_1 . At last, the absence of contact metamorphism allows us to say that the mesozonal low-pressure regional metamorphism was characterized by a T^0 about 510°C-580°C for 1.5-3.3 Kbars in pressure.

The geochronology (K/Ar method) has provided about 280-285 My for the biotites of micaschists, about 290 My for the granite's and 295 My for the trondhjemite's. We obtained comparable results (295-296 My) for small muscovites of quartz veins while ages about 315-305 My were found for large scale muscovites of the granitic mass as one pegmatitic facies. The younger ages (280-295 My) underline the end of a final metamorphic episode connected with the end of granitizations in South Brittany. We have noticed that the reopening of micas was associated with this event. Moreover, we believe that the ascent of the pluton took place at about 315-305 My or slightly before.

The determination of the regional stress axis has been realized by informatic methods at the U.S.T.L., Montpellier, France. This research relied on the program created by ETCHEPAR A. (1984) has end up to determine one N150°E-N160°E compression related to WNW-ESE strike-slip faults.

This belt along the S.A.S.Z. shows a complex evolution underlined by other granites as Pontivy, Rostrenor or Lizio which have different ages, mineralogy or structural behaviour. So, systematic detailed studies on each granites body could help us to understand the chronology and mechanism of the hypercollision process during these Carboniferous times.

KEER A.*, EGLINGTON B.M.** , MILNE G.C.*
- Geological, geochemical and isotopic studies on proterozoic granites from Natal, South Africa

The Natal Structural and Metamorphic Province (NSMP) is exposed in Natal as an almost continuous elongate erosional inlier which trends subparallel to the coast for almost 250 km. It is essentially composed of supracrustal high-grade gneisses and granitoids which, on various grounds, are thought to be the eastern continuation of the Namaqua Metamorphic Province. These two provinces have, together, been referred to as the Namaqua-Natal Mobile Belt (MATTHEWS, 1972; TRUSWELL, 1977).

Previously published age determinations (NICOLAYSEN and BURGER, 1965; BURGER and COERTZE, 1975-6) on mineral separates from rocks in the NSMP are in the range 1016-950 Ma and have been interpreted as dating cooling after the prominent «1000 Ma Namaqua-Natal» metamorphic events (SACS, 1980).

The NSMP can be subdivided into two major east-west trending terranes on the basis of lithological, structural and metamorphic features (cf. MATTHEWS, 1981). These are:

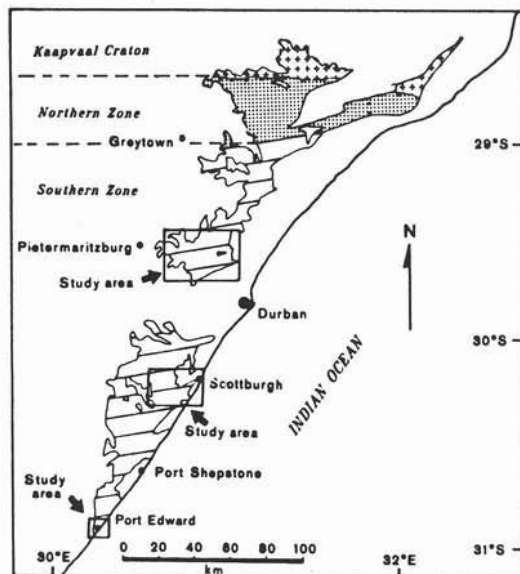
- a northern zone 15-30 km wide which defines the southern boundary of the Archean Kaapvaal craton and is thought to represent the metamorphosed and deformed upper of an obducted ophiolite sequence (MATTHEWS, 1972). It is characterised by extensive thrust sheets of predominantly amphibolitic gneisses;
- a southern zone at least 200 km wide, which is composed of alternating linear belts of supracrustal gneisses, magmatites and granitoid intrusions with granitic material becoming more extensive in the south. These rocks comprise the Mapumulo Group (SACS, 1980). Rocks of the granulite facies and charnockites form a major proportion of the most southerly sector of the terrane.

Over the past two decades, an extensive research programme has been undertaken on selected areas within the NSMP with particular emphasis on the abducted northern zone (see MATTHEWS, 1981; for references). The present contribution describes the chemical characteristics of some of the major granitoid rocks from three selected areas within the previously little-known Mapumulo Group (Fig. 1). Until recently only limited geological investigations had been undertaken on the rocks of the southern zone, with geochemical and isotopic data almost completely lacking.

The Valley of a Thousand Hill's area

KERR (1985) has described a large composite pluton of megacrystic granites which he termed the Mgeni Megacrystic Granite. Seven distinct lithological varieties were recognised and divided into three different suites. Suite I contains pyroxene- and hornblende-bearing granites and four members have been identified. It is the least silicic (59-70% SiO_2) and richest in Ti, Al, total Fe, Mn, Mg, Ca, Sr, Ba, Zr, Zn and Nb. The rocks also show many characteristics of A-type granites, having

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high Fe/Mg ratios (~ 0.9) and being richer in total Fe, alkalis, K, P, and Ti and poorer in Mg, Ca and Na than the average granite analyses in the literature. Suite II has two biotite-bearing and peraluminous members, is fairly silicic (67-77% SiO_2) and has many chemical features of S-type granites.

The age relationship between these two suites is problematic in that the close spatial arrangement and textural similarities suggest that they may be cogenetic. However, preliminary dating gives an isochron of ~ 1000 Ma for suite II whereas results for suite I using various methods, show a range of ages from > 1100 - 1000 Ma (BURGER and WALRAVEN, 1980; unpub. data). Various chemical plots of the two megacrystic suites do, however, suggest a gradation from A-type suite I to a more calc-alkaline suite II with a concomitant increase in the $^{87}\text{Sr}/^{86}\text{Sr}$ initial ratio (0.704-0.708). Thus there may be a change in this region from granites with a within-plate chemical signature to a more calc-alkaline character.

Suite III, consisting of the Nqwadolo granite, is even-grained and chemically distinct with extremely high Rb/Sr, high Ba/Sr and a high $^{87}\text{Sr}/^{86}\text{Sr}$ initial ratio. In addition, Rb, Pb, Y, Th and U contents are the highest and Sr the lowest of the three suites.

The country rock gneisses (Nagle Dam formation) are essentially composed of highly deformed intermediate biotite, biotite-hornblende- and hornblende-gneisses with minor components of pelitic, acidic, basic and ultrabasic rocks. Chemically, they show a strong calc-alkaline signature and this contrasts with the ocean island tholeiite character of amphibolitic inclusions within the Mgeni granite. Associated with these amphibolites are metacherts, marbles and calc-silicate gneisses, pelites, acidic and intermediate gneisses and Mn-rich gneisses.

The Umzinto area

EVANS, EGLINGTON, KERR and SAGGERSON (with

publishers) describe a sequence of supercrustal gneisses (the Mzinto formation) which have been intruded by basic and acid suites. The felsic intrusive rocks pre- and post- date the main basic intrusion (the Equeefa metabasite). The earlier granitoids can be divided into a calc-alkaline member (the Woodcote tonalite) and the mesocrystic Glen Rosa granite. The former has many features typical of I-type granites whilst the latter is rich in Si, Ba, and Y and low in Al, Mg, Rb. The K/Na ratio is close to unity and the high Fe/(Fe + Mg) (0.96) suggests chemical characteristics similar to A-type granites.

The Equeefa metabasite suite is the largest occurrence of basic material south of the northern boundary zone and consists of a variety of basic to ultrabasic lithologies, all of which have a within-plate chemical signature. It has been dated at 1024 ± 32 Ma and has been metamorphosed in the 1000 Ma event.

Five granitoid intrusives post-date the Equeefa metabasite suite and show a trend of increasing A-type character with time. The early Humberdale and Scottburgh granites are syn- to late-tectonic whilst the Sezela quartz-monzonite is late- to post-tectonic. These three granitic bodies have many chemical and mineralogical similarities which suggest some genetic relationship. The later (878 ± 22 Ma) Fafa granite is megacrystic and shows a strong A-type character.

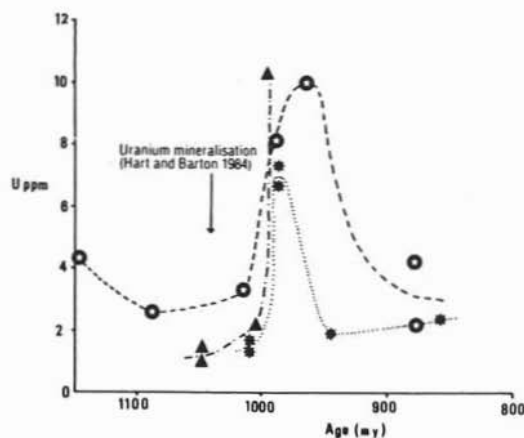
The port Edward area

EGLINGTON, HARMET and KERR (1986) described four main granitic plutons from the southern part of the NSMP. Ages range from 1012 Ma to 859 Ma. The Port Edward enderbite has a fairly restricted range of SiO_2 (55-60%) with Ti, Fe, K, P higher and Mg, Ca lower than average granitoids with similar silica contents. The Bomela charnockite also shows a restricted silica range (62-65% SiO_2) with low Mg, Ca and high K. Fe/(Fe + Mg) ratios for these two granites are high, typical and of A-type granites and they are also enriched in Zn, Nb, Zr and Y relative to calc-alkaline granites.

The Nicholson's Point and Glenmore granites are similar to each other but display some difference in trace element concentrations. The former is slightly enriched in Rb, K, Ba, Pb, and Zr and the later in Rb, K and P relative to calc-alkaline granites. Unlike the Port Edward enderbite and Bomela charnockite, these two granites cannot be confidently described as having A-type characteristics although the charnockitic nature of some exposures of the Nicholson's Point granite might be an indication that there is some affinity with such granites.

Discussion

The present data, although derived from studies of three distinct areas, indicate that many of the Proterozoic granites in Natal have moderate to strong A-type characteristics and display ages ranging from 1200-860 Ma. This indicates that significant volumes of melt were introduced into the crust over a period of ~ 350 m.y.; both pre- and post- dating the major tectonometamorphic event which occurred at approximately 1000 Ma; whilst field investigations suggest that the granites were



everywhere intruded into previously deformed supracrustal gneisses, the basement to which has not yet been identified.

Isotopic work (BARTON et al., 1981; EGLINGTON and HARMER, 1984; EGLINGTON et al., 1986) have suggested that the granites were derived by reworking of a relatively juvenile protolith and that no significantly older components such as the Archaean rocks to the north were involved.

In contrast to the Namaqua Metamorphic Province, little economic mineralisation has been found in the Natal sector of the Namaqua-Natal Belt although locally enriched occurrences are known. A survey of possible uranium occurrences found that there was a relationship between the U concentration and Rb-Sr whole-rock age. This relationship was unrelated to chemistry, textural nature or structural position of the plutons, with a significant increase in the U concentration being displayed by all granites intruded circa 1000 Ma, i.e. coinciding with the major tectonometamorphic event (Fig. 2). Whether this represents a major introduction of uranium into the crust at this time or re-concentration through scavenging by the rising plutons is unknown.

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LAGO M.*, ENRIQUE P.**, POCIVI A.*, VAQUER R.** - *Occurrence and characteristics of granitoid xenoliths in calcalkaline dikes of a variscan Massif of the Iberian Chain (NE Spain)*

Hypabyssal dikes of basaltic-andesite and rhyolite are frequently found in the Montalbán variscan outcrop (Iberian Chain, NE Spain; Figs. a, b) and c). They have calcalkaline composition and are of the Stefanian-Permian age. Different granitoid xenoliths occurs in some of these andesitic dikes. They are elongated parallel to dike (Fig. d). Some data about petrological and geochemical composition are included.

The xenoliths and variscan granitoids of neighbouring areas (Central Iberian Zone and Pyrenean area) are compared in the basis of these data in order to give some petrological remarks.

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