STRUCTURAL EVOLUTION IN N MOÇAMBIQUE - MILANGE, MOCUBA AND INSACA-GURUE SHEETS

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Introduction

Mapping at 1:250,000 scale of the Milange, Insaca-Gurúè and Mocuba sheets, northern Moçambique, has generated a new understanding of the geological evolution in this area. Pre-existing maps showed the rocks in these areas as belonging to 3 tectonostratigraphic units that we have termed "complexes" namely, the Unango, Ocua and Nampula Complexes, from NW to SE, respectively.

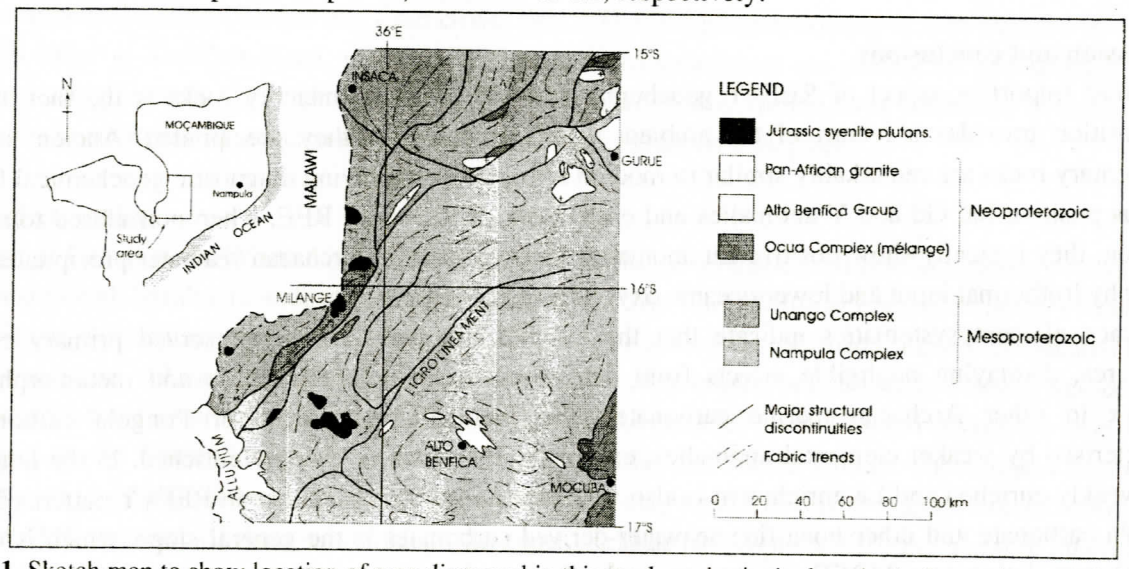

Figure 1. Sketch map to show location of area discussed in this work, and principal geological complexes and structural features.

Structural Evolution in the Nampula Complex

Protoliths of all three complexes are of Mesoproterozoic age. U-Pb SHRIMP dates of zircons from orthogneisses within the Nampula Complex, which occupies the most south-easterly part of the area, yielded dates of 1117± 21 and 1098 Ma, suggesting that deposition of the volcano-sedimentary rocks into which the orthogneiss plutons were intruded - now represented by the Alto Molocue Group - occurred prior to this. Isoclinal folding, with limbs that were parallel to the earliest axial planar cleavage was the earliest deformation preserved in these rocks, evidenced by rarely-preserved trails of heavy minerals in quartzite. This folding was accompanied by high-grade metamorphism and partial anatexis that gave rise to extensive leucosome generation now present as stromatic layers parallel/sub-parallel to compositional banding. Metamorphism at amphibolite to granulite grade, followed by later, widespread retrogression, also took place prior to 610 Ma, after which (now) metamorphosed quartz-rich sediments, including metamorphosed pseudo-conglomerates (Alto Benfica Group) were deposited unconformably on the pre-existing basement. The present-day distribution of these metasediments is restricted, suggesting that only remnants of more widely distributed deposits that have been preserved in down-faulted basins generated during extensional tectonics in this earliest phase of deformation.

NW-SE plunging folds deform both the Nampula basement and the Alto Benfica Group and generate variably close to open fold hinges, commonly associated with a spaced axial planar cleavage striking SE or

NW, with suggestion of some later refolding. Some development of patchy, discontinuous leucosome appears to be associated with this phase of folding; charnockisation, growth of feldspar laths across the main foliation in the Nampula basement gneisses and metamorphism of the quartz-rich sediments probably also occurred at this time.

Metamorphic ages for Nampula Complex rocks are 535±28 and 488±5 Ma, suggesting that metamorphism was synchronous with the emplacement of an intrusion now consisting of biotite-orthogneiss (508±3 Ma), during the Pan-African episode. Weak foliations within these largely undeformed igneous bodies suggest that the final major phase of deformation in the area – formation of NE-SW trending folds and axial-planar flattening – was, at least in part, coeval with Pan-African granite intrusion.

Structural Evolution in the Unango Complex

The NW part of the area is dominated by rocks assigned to the Unango Complex. These are also generally accepted to have protolith ages of around 1000 Ma, and recent SHRIMP ages allied to this study do not challenge this assumption, except to give some evidence for a younger tectono-magmatic event at ~800 Ma. The Unango / Nampula Complex boundary is deduced to be tectonic, as an abrupt change of lithology and metamorphic grade (from lower to upper amphibolite facies) occurs across it. Pods of mafic-ultramafic rock occur along it SW of Milange. Field evidence indicates that the earliest deformation phase in the Unango rocks was dominated by isoclinal folding accompanied by extensive leucosome formation, probably related to an episode of compression in the Mesoproterozoic. Extensive accumulations of leusosome around extended and deformed paleosome material, commonly incorporating dissociated fold hinges, generate some agmatitic textures. NNW to NW plunging fold axes deform earlier foliations, which are in turn locally re-oriented by NE-trending folds, the fold hinges of which have variable plunge. SHRIMP data suggest that metamorphism of the Unango Complex rocks occurred between 584 and 544 Ma, that is, at a similar time to that of the Nampula Complex.

Structural Evolution in the Ocua Complex

Previous maps show the Lurio Belt extending continuously in a NE-SW trend across the area, separating the Unango and Nampula Complexes. The granulite-facies rocks were previously grouped into the Lurio Supergroup, but to avoid confusion with the "Lurio Belt", these have been assigned to the newly-defined Ocua Complex, here comprised of rocks characterised by the coexistence of either orthopyroxene + quartz or orthopyroxene + clinopyroxene ± garnet. The distribution of these rocks is significantly more restricted than indicated on previous maps, particularly in the west of the area where their occurrence is limited to discontinuous pods and slivers. In these rocks, a set of isoclinal folds associated with strong NW-plunging lineations are the earliest phase of deformation identified, overprinted by NE and SW plunging open to close folds that are locally axial planar to NE-SW oriented foliations and local shear zones with a similar trend.

Synthesis of structural events

Spatial variation of foliation, lineation and fold-hinge directions suggests that the sequence of structural events discussed above for each of the complexes is not uniform across the area. The quartz-rich meta-sediments of the Alto Benfica Group, on the Mocuba and eastern Milange sheets exhibit folding around NW-axes, and the 610 Ma date from zircon in these rocks provides an upper limit on the timing of NW-plunging folds and the earlier phase of migmatisation, metamorphism and tight isoclinal folding that generated the foliation surfaces deformed by this folding.

NW-SE trending foliations and fold hinges and lineations plunging mainly NW dominate the south-eastern parts of the Mocuba and Milange sheets; a NE-SW trending zone of foliations trending NE and lineations plunging NE is present in the north-western parts of these sheets, and field observations indicate generation of these structures in a later (i.e. post-610 Ma) tectonic event. Tectonic discontinuities between the Nampula,

Unango and Ocua Complexes are aligned in this orientation; the absence of widespread, well-developed tectonic fabrics and sense-of-movement indicators suggests large-scale excision perhaps occurred along the contacts. Geophysical data corroborates the diminishing presence of the Ocua Complex to the SW, but the boundary between the Unango-Nampula complexes is continuous.

Indirect evidence for the timing of these structures suggests they formed prior to the emplacement of the majority of Pan-African intrusions, with some continued tectonic activity during the intrusive event. Crustal thinning responsible for generating the NE-SW structures may also have been the trigger for granite emplacement, the final phase in the Mesoproterozoic to Cambrian evolution of the geology in northern Moçambique.

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