U-PB GEOCHRONOLOGICAL STUDY OF THE SPECULARITE-HEMATITE-BEARING MARAMPA GROUP AND KENEMA ASSEMBLAGE, SIERRA LEONE

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The Marampa Group occurs within the Rokel-Kasila Belt which runs approximately north-south in Sierra Leone and Liberia. The Rokel-Kasila Belt is a metamorphic belt that developed during the late-Neoproterozoic collision between the West African and Amazonia Cratons of South America. It is comprised of four belt-parallel zones, from west to east the granulite-facies Kasila Group, the amphibolite-facies Marampa Group, reworked Archaean basement known as the Kenema Assemblage and the sub-greenschist-facies Rokel River Group. There appears to be consensus on the Archaean age of the Kasila Group and Kenema Assemblage, and the late-Neoproterozoic to Cambrian age of the Rokel River Group, but the age and tectonic significance of the Marampa Group remain enigmatic. We describe the petrography of the Marampa Group rocks; report protolith and metamorphic ages of rocks of the Marampa Group and the Kenema Assemblage from U-Pb zircon dating and use these data to infer the tectonic evolution of the region.

The Marampa Group has been subdivided into two Formations: the lower Matoto Formation comprised of mafic and ultramafic volcanic units, and the upper Rokotolon Formation, dominated by metapelitic units and subordinate metapsammite. It is in the micaschists of the Rokotolon Formation that the mineralised specularite-hematite units occur, which in places form several 100-m-thick accumulations. The specularite-hematite have been mined by DELCO until the mid 1970s and are currently being explored by several companies (e.g. Cape Lambert Annual Report 2009). Field mapping reveals that the specularite-hematite schist has undergone at least four phases of deformation, and is fine- to medium grained with a peak metamorphic assemblage of quartz – hematite – albite – white mica – epidote – magnetite – apatite – tourmaline ± calcite ± garnet ± hornblende. Iron oxide minerals are represented by specularite-hematite (up to 60 modal%) and subordinate magnetite (usually < 2-3 modal%) and were formed as part of the prograde metamorphism. Interestingly, the iron mineralisation appears to be accompanied by manganese-rich units.

In the garnet-bearing quartz-muscovite-biotite-albite schist of the Marampa Group, there are at least seven clusters of concordant/sub-concordant ages at c. 2040, 1960, 1500, 1110, 580, 400 and 350 Ma. Together with the zoning patterns shown in CL imagery, we interpret the provenance of the detrital zircons spanned Palaeo- and Meso-proterozoic times. The rock has a maximum deposition age of c. 580 Ma with apparent younger ages related to Pb-loss. Three samples of the Kenema Assemblage were dated. Apart from a single zircon which yielded a concordant age of 3119 ± 20 Ma, most zircons in the migmatitic gneiss define a discordia with a c. 2900 Ma upper intercept and a poorly defined c. 460 Ma lower intercept. If we only consider the oldest five points, a concordia age of 2903 ± 16 Ma (MSWD = 0.33) can be calculated. Data from another gneiss sample of the Kenema Assemblage form a discordia with an upper- and lower- intercept of c. 3110 and 500 Ma respectively with a high MSWD which is interpreted to reflect multi-stage Pb loss. The third sample is a porphyritic granite, inferred to intrude the Kenema Assemblage. Apart from five concordant grain cores, which have an age of 2854 ± 13 Ma (MSWD = 3.10), most data form a discordia that has an upper intercept of c. 2860 and a poorly constrained lower intercept of c. 420 Ma. We interpret the concordia age as the best estimate for crystallisation of the granite.

The age and tectonic significance of the Marampa Group remain controversial. It has been variously interpreted as a metamorphic equivalent of the Neoproterozoic Rokel River Group or a klippen of the Archaean Kasila Group. In a third interpretation, the Marampa Group represents a Pan African orogen suture zone, with the Marampa Group rocks representing the metamorphosed oceanic lithosphere and overlying sediments and the Kenema Assemblage interpreted to be a root zone of an accreted island arc (Lytwyn et al. 2006). Available radiometric ages from the Marampa Group schist include a K-Ar muscovite age of c. 560 Ma (Beckinsale et al. 1981), interpreted to record cooling after metamorphism. The U-Pb ages recorded here provide new constraints on these hypotheses. The Kenema Assemblage comprises units with ages 3110, 2900 and 2850 Ma, similar to ages reported further east in the West African Craton (Thieblemont et al. 2001 and references therein). The new results indicate the accretion in the south western part of the West African Craton may have begun in 3100 Ma and experienced significant growth and plutonism during the Leonian and Liberian events. The absence of Archaean detrital zircons in the Marampa schist suggests that the Marampa Group was deposited far from either the Archaean West African Craton or the Kenema Assemblage. This, together with the presence of ultramafic and mafic units in the Matoto Formation, appears to support the suture model of Lytwyn et al. (2006). The Marampa Group might have formed in an ocean basin and iron- and manganese rich sediments are speculated to have derived from seafloor volcanism. Our lower intercepts, although imprecise, support a metamorphic event which occurred in the latest Neoproterozoic or earliest Cambrian.

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Biographies

Gavin Chan is a Consultant, while Bert De Waele is a Principal Consultant with SRK Consulting in Perth, Australia.

Gavin obtained his doctoral degree from Oxford University with extensive experience in field and structural mapping and interpretation as well as knowledge of geochemical and geochronological data analysis. Gavin worked in the Troodos Massif in Cyprus and in the Himalaya (Tibet), and has since developed his mapping skills in several resource projects worldwide covering lode gold, sediment-hosted Cu-Co, BIF and sandstone-hosted uranium.

Bert worked for over 10 years in central Africa in a variety of roles, including regional mapping geologist for the Geological Survey, and lecturer/researcher at the University of Zambia. Bert obtained his PhD at Curtin University of Technilogy, applying field mapping, geochemistry and geochronology to unravel the tectonic evolution of central Africa. He joined the British Geological Survey, where he was in charge of mapping and geochronological work on a Worl Bank funded mapping programme in Madagascar. He since has joined SRK Consulting, providing structural mapping services to the mining/exploration industry world-wide.