PRISE

PRISE had an exceptionally productive year in providing access to the wide range of equipment and expertise in isotope geochemistry and geochronology available in the Research School of Earth Sciences. As considerable time was devoted to the development of the SHRIMP II multicollector, ***PRISE*** productivity on this front was less than anticipated. However, Ar-Ar and K-Ar studies were prominent and the secondment of Dr Wayne Taylor enabled laser ablation ICP-MS and electron probe projects to be undertaken, many with specific relevance to the diamond industry.

PRISE hosted the following visitors to the School during 2000:

Dr J. Aleinikoff, Branch of Isotope Geology, US Geological Survey, Denver, USA
Dr R. Pankhurst and Dr I. Millar, British Antarctic Survey, Keyworth, United Kingdom
Dr C.W. Rapela, Centro de Investigaciones Geologicas, Universidad de la Plata, Argentina
Professor F. Hervé, Department of Geology, University of Chile, Santiago, Chile
Professor T. Watanabe and Ms K. Takano, Geology Department, Hokkaido University, Japan
Professor D. Gebauer and Ms A. Liati, Department of Earth Sciences, ETH Zürich, Switzerland
Dr A. Cocherie, Bureau de Recherche Géologique et Miniere, Orleans, France
Mr D. Jamal, Dept. of Geological Sciences, University of Cape Town, Cape Town, South Africa
Dr M. Poujol, Dept. of Geology, University of the Witwatersrand, Johannesburg, South Africa
Dr G. Teale, Teale and Associates, Prospect, South Australia
Dr A. Morton, British Geological Survey, Keyworth, United Kingdom
Dr D-L. Cho, Department of Geology, Korea Institute of Geology, Mining and Minerals, Korea
Dr J. Goodge, Southern Methodist University, Dallas, Texas, USA
Dr C. Barnes, Department of Geosciences, Texas Tech University, Texas, USA
Messrs M. Schwarz and A. Burtt, Primary Industry and Research, South Australia
Mr W. Board, Dept. of Geological Sciences, University of Cape Town, Cape Town, South Africa
Professor S. McCourt, Dept. of Geology, University of Durban-Westville, Westville, South Africa
Dr A. Camacho, Department of Applied Geology, University of New South Wales

Modal metasomatism in the Kaapvaal Craton lithosphere: constraints on timing and genesis from U-Pb zircon dating of metasomatism peridotites and MARID-type xenoliths

J. Konzett[1], R.A. Armstrong and D. Günther[2]

Modal metasomatism in the Kaapvaal Craton lithosphere is well documented in upper mantle xenoliths sampled by Group 1 (mainly late Cretaceous) and Group II (mainly early Cretaceous to late Jurassic) kimberlites in the Kimberley area, South Africa. The metasomatic style is characterised by the introduction of K, H and large ion lithophile/high field strength elements into the lithospheric mantle leading to the crystallisation of hydrous potassic phases such as a phlogopite and/or K-amphibole. Textures indicate that the hydrous phases either replace pre-existing assemblages in peridotites, forming the metasomatised peridotite suite (phlogopite – K-richterite – peridotites, = PKP suite), or crystallise from K-rich melts, forming the mica-amphibole-rutile-ilmenite-diopside (MARID) suite of xenoliths. These K-rich assemblages become potential low-melting source components for alkaline incompatible trace element enriched magmas. The timing of metasomatism and its temporal and possible genetic relation to kimberlite magmatism is poorly constrained because of the rarity of phases in the metasomatic assemblages that are suitable for precise dating. We have used SHRIMP to obtain U-Pb formation ages of 88 ± 2 Ma (1σ) and 82 ± 3 Ma for zircons from a PKP and a MARID xenolith respectively, that were recovered from a Group I

[1] Geophysical Laboratory, Carnegie Institute of Washsington, USA
[2] Laboratory of Inorganic Chemistry, Zurich, Switzerland

kimberlite. Both the PKP and MARID U-Pb zircon ages are indistinguishable from emplacement ages of Group I kimberlites in the Kimberley area. One exceptionally old spot analysis of 102 ± 5 Ma from a PKP zircon provides evidence for modal metasomatism predating Group I kimberlite emplacement by several million years, with minor resetting of the U-Pb isotopic system of most analysed PKP zircons to a Group I emplacement age. Detailed textural and mineral chemical analysis, including high energy X-ray mapping and analysis of fluid inclusion daughter crystals, indicates a complex reaction history for both PKPs and MARIDs. U-Pb zircon ages from this study can be combined with literature data and experimentally-derived models to suggest that MARID formation is concurrent and genetically related to *both* Group I and Group II kimberlite magmatism (at least in the Kimberley area). MARID and PKP zircon ages are also consistent with an earlier suggestion that metasomatised peridotites may form from interaction of hydrous fluids expelled by solidifying MARID-type melts with peridotitic wall rocks.

Hydrothermally altered archaean felsic volcanics from the Mt. Hope area, Eyre Peninsula, South Australia

G.S. Teale[3] and C.M. Fanning

In southern Eyre Peninsula, South Australia the Archaean to Proterozoic of the Gawler Craton comprises the supracrustal Carnot Gneisses (Sleaford Complex) that underwent prograde granulite facies metamorphism at ~2420 Ma and which represent a lower crustal segment that was juxtaposed with higher crustal level granitoids (the Dutton Suite) at about 2000 Ma. An aeromagnetic image of the southern Eyre Peninsula highlights the boundary between the magnetically intense layered Carnot Gneisses and the magnetically quiet region of the Dutton Suite (~2520 to ~2560 Ma). In the east, the Kalinjala Mylonite Zone, D_3 of the Kimban Orogeny (~1710 Ma), separates the Palaeoproterozoic Hutchison Group (≥ 1860 Ma) from the ~1850 Ma Donnington Granitoid Suite. In the west the Warrow Quartzite (Hutchison Group) is seen to unconformably overly the Kiana Granite (Dutton Suite).

A prominent, intense north-south trending magnetic anomaly occurs between Price Island and Lake Hamilton on the western Eyre Peninsula. The anomaly arises from the presence of the magnetite-rich, quartz-muscovite-spessartine garnet phyllites as seen in outcrop on Price Island and in the Lake Wangary drill hole intersections on Coffin Bay Peninsula. Detrital zircon U-Pb age signatures indicate a major igneous component at ~1765 Ma, with no younger zircons. Older zircons are also present reflecting provenance from the Carnot Gneisses and Dutton Suite. These phyllites are clearly not part of the Hutchison Group *sensu stricto*, but may be correlatives of the Wallaroo Group, Yorke Peninsula.

In the Mt Hope area, the N-S magnetic anomaly is off-set and more recent and detailed drilling to the north intersected a sequence which contains “quartz-eye” felsic meta-volcanic rocks that have undergone hydrothermal alteration prior to metamorphism. These meta-volcanics can now contain abundant to minor chloritoid, andalusite, muscovite, chlorite, kyanite, spessartine garnet, zincian staurolite, gahnite and disseminated chalcopyrite and sphalerite. Beds of carbonaceous phyllite can be intercalated with the meta-volcanics and are apparently underlain by mafic schists, magnetite-rich meta-pelites, silicate iron formations, tremolite marbles and calcsilicates. Anomalous base metal and gold results have been returned from the felsic metavolcanics and the other altered rock-types. SHRIMP U-Pb zircon analyses of two meta-volcanic layers reveals a dominant 2520 ± 7 Ma zoned magmatic component with inheritance to a major peak at 2720 Ma. No younger zircons have been found thus far. The presence of probable Archaean felsic volcanic rocks in the southern Gawler Craton is of great significance to both the tectonic evolution of the Craton and its mineral potential.

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[3] Werrie Gold Ltd., P.O. Box 740, North Adelaide, S.A. 5006

$^{40}Ar/^{39}Ar$ and K-Ar whole rock age constraints on the timing of regional deformation, south coast of New South Wales, Lachlan Fold Belt, Southeastern Australia: problems and implications

D. Phillips and C.L. Fergusson[4]

Subduction complex rocks are well exposed on the south coast of New South Wales around Batemans Bay. Farther south in the Narooma and Bermagui region, other workers have determined two $^{40}Ar/^{39}Ar$ ages of 450 ± 3 Ma and 445 ± 2 Ma. They argued that these ages constrain the timing of intense underplating-related deformation. We have undertaken K-Ar and $^{40}Ar/^{39}Ar$ dating on slate samples, from an area south of Batemans Bay, to test the earlier controversial suggestion that structures previously attributed to late Silurian deformation, on the basis of regional structural constraints, are now considered to be of Late Ordovician age. The $^{40}Ar/^{39}Ar$ method as applied to fine-grained, low temperature metamorphic rocks such as slates, is beset by two main problems. Firstly, the fine grain-size of the illite present may result in recoil loss and/or redistribution of ^{39}Ar during irradiation, resulting in elevated $^{40}Ar/^{39}Ar$ ages. Secondly, there is the problem of distinguishing between the contributions to $^{40}Ar/^{39}Ar$ spectra from illite/muscovite grown during the cleavage-producing deformation and that from detrital muscovite/illite. This problem is particularly acute in the Ordovician turbidites of the Lachlan Fold Belt as the sedimentary micaceous component is very common and present in nearly all sandstone and siltstone and is also present along bedding planes in mudstone.

In the current study, four slate samples, with variable contents of detrital white mica, were analysed by both the K-Ar and $^{40}Ar/^{39}Ar$ step-heating methods. A separate of detrital white mica from one slate sample yields a plateau age of 500 ± 2 Ma. This result indicates that inheritance has not been eliminated by metamorphism as is commonly assumed and that the $^{40}Ar/^{39}Ar$ ages provide only a maximum estimate for the timing of deformation. $^{40}Ar/^{39}Ar$ analyses of slate chips yield discordant, saddle-shaped age spectra, with minimum 'within-saddle' ages of about 420 Ma. Two slate samples give identical $^{40}Ar/^{39}Ar$ integrated ages of 455 ± 2 Ma. One sample contains relatively abundant detrital bedding-parallel mica flakes that are crenulated parallel to the regional cleavage in the rock. The $^{40}Ar/^{39}Ar$ ages are some 20 Ma older than K-Ar ages for these same samples, suggesting that recoil loss of ^{39}Ar may also have affected these slates. Both recoil loss of ^{39}Ar and inherited white micas will yield elevated apparent ages, thus providing only maximum ages for the cleavage-producing deformation. Two other samples from slaty tectonic mélange and intensely cleaved slate have been analysed and have $^{40}Ar/^{39}Ar$ integrated ages of 422 ± 2 Ma (K/Ar 424 ± 5 Ma) and 415 ± 2 Ma (K/Ar 429 ± 5 Ma). The general consistency of these results accompanied by microstructural observation indicating a low abundance of detrital mica, show that in these samples recoil and inheritance problems appear to be minimal. Thus they provide a more reliable upper constraint on the timing of the regional deformation on the south coast of New South Wales, i.e. younger than about 420 Ma, consistent with previously recognised regional structural constraints.

Elsewhere in the Lachlan Fold Belt $^{40}Ar/^{39}Ar$ ages have been used to constrain the timing of deformation and to document elaborate tectonic models involving diachronous deformation and formation of subduction complexes. The current results raise serious questions regarding the validity of these conclusions.

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[4] School of Geosciences, University of Wollongong, NSW 2522