Iapetus oceanic lithosphere preserved in the Bay of Islands ophiolites in Newfoundland represent a fossil ridge-transform segment and associated low angle normal fault formed at an inside corner structural setting similar to recently discovered core complexes at oceanic ridge-transform intersections (TSRC Pub #102). However, the Newfoundland ophiolites segment developed in a setting where a spreading centre propagated across a transform margin and rifted older arc-type lithosphere. Factors that contributed to formation of the low angle detachment fault are the lithospheric nature of the mantle basement, rheological weakening and strain focusing by intrusive sills, and weak lateral coupling realised by the extensional transform assemblage.

Outcomes: Seven papers were published in 2001 (TSRC Publ. #92, #102, #105, #117, #139, #143, #148).

Aims for 2002:

In 2002 we hope to constrain the position of Laurentia in the Neoproterozoic and to establish the nature of the conjugate margins. The width of the Iapetus Ocean and the position of Laurentia during the latest Neoproterozoic and early Palaeozoic remain a source of continuing debate. To try to resolve these issues we will commence a field, palaeomagnetic and geochemical study of rift-related sediments and igneous rocks preserved in the Atlantic provinces of Canada. Work is continuing with Martin Smith of the British Geological Survey on the provenance of the Dalradian Supergroup of Scotland and its implications for continental reconstructions. Cawood will review the rift-to-drift history of the west Laurentia margin in Eastern Australia and Antarctica. Dalziel will investigate the possibility that the Kalahari craton collided with the Texas region as well as continuing work on possible East Laurentia-South American connections and implications for end-Neoproterozoic to early Palaeozoic palaeogeography.

Participants: Associate Professor P.A. Cawood, Professor I.W.D. Dalziel, Drs A.A. Nemchin, and P. Kinny, Ms S. Loewy (PhD student). Also Drs J. Connelly (University of Texas), M. Smith, (British Geological Survey), W. Thomas (University of Kentucky, USA), R. Astini (Universidad Nacional de Cordoba, Argentina), P. McCausland (University of Western Ontario, Canada), G. Suhr (University of Cologne), Ms K. Thrane and Dr J. van Gool (Geological Survey of Denmark and Greenland), Drs C. Friend and R. Strachan (Oxford Brookes University, UK), Dr N. Soper (University of Sheffield, UK) and Dr G. Watt (University of Aberdeen).

Project 2.2.1: The Irumide Belt of Zambia, East African Orogen

Aims:

The Mesoproterozoic Irumide belt of Zambia occupies a central position in a criss-crossing network of orogenic belts that characterises south-central Africa, and presents a unique opportunity to study the tectonic processes active prior to events leading to the East African orogeny. This elongate belt trends northeast-southwest and comprises granites and metasediments. It is truncated to the northeast by the reactivated Paleoproterozoic Ubendian belt, and to the southwest by the Neoproterozoic Lufilian Arc and Zambezi belt terranes. One aim of the project is to constrain the tectonic setting, internal structure, tectonothermal evolution and age of the Irumide Belt, and place it in the regional network of African Mesoproterozoic orogenic belts. A second goal is to understand better the relationship between the Irumide belt and its southeastern extension into the Mozambique belt terrane, which was reworked within the extensive Neoproterozoic East African Orogen. The resolution of these two issues will provide much of the information required to complete the western half of a tectonic cross-section across the East African Orogen, which is the overall aim of the parent Project 2.2.

A third goal of the project aims to evaluate the nature and timing of high-pressure metamorphism in the Zambezi Belt of northern Zimbabwe and southern Zambia, which relates to the Congo-Zimbabwe collision in Neoproterozoic times.

Progress:

Dr Simon Johnson is evaluating proposed metasomatic and tectonic models for the Chewore inliers in Zimbabwe (based on his work in 1999-2000), through investigation of the

occurrence of high-pressure rocks in the Chiawa and Chongwe Rivers of southern Zambia. Rocks collected in 1999 by Dr Simon Johnson and Mr Crispin Katongo (University of Zambia) are currently being analysed by microprobe to determine their peak metamorphic pressures and temperatures and to investigate the nature of their metamorphic and metasomatic development. Preliminary results indicate that these high pressure rocks display a very similar tectonic and metasomatic evolution to those in the Chewore Inliers, thus upholding the proposed tectonic model.

Mr Bert De Waele started PhD studies at the TSRC Curtin node in March 2001. His research is focussed on the structure, metamorphism and geological history of the Irumide belt, and their implications for the assembly and dispersal of Rodinia, building upon his extensive knowledge of Zambian geology. He continued work on samples collected during fieldwork in the Irumide belt in 1999 (with Dr Michael Wingate) and 2000 (with Dr Francis Tembo and Mr Crispin Katongo, University of Zambia), and also in the Zambian section of the East African Orogen in 2000 (with Dr Toby Rivers, Memorial University, Dr Francis Tembo and Mr Crispin Katongo). Geochemical data from the Serenje, Mupamadzi and Chinsali areas of the Irumide belt indicate that pre- syn- and post-tectonic granites from this region all have strong A-type characteristics. Further work is underway to determine whether this chemical signature reflects melting of an enriched lower crustal source, or whether granite emplacement occurred within an extensional or shear zone setting. There are at present insufficient geochemical data to make any reliable interpretations of their tectonic setting, but more samples have now been collected. A total of 27 crushed samples from the Zambian Mozambique belt are ready for geochemical analysis.

In May 2001, Mr De Waele was invited to the Museum of Central Africa in Tervuren (Belgium) to discuss work in the Irumide belt and link up with a team of researchers at the Museum who are working on the coeval Central African Kibaran belt in Congo D.R., Rwanda, Burundi and northwest Tanzania (Drs Luc Tack, Max Fernandez-Alonso and Dr Andre

Professor Toby Rivers (University of Newfoundland, Canada, TSRC visitor, 2001) and Benjamin Mapani (University of Zimbabwe), closely examining a garnet bearing granite-gneiss in the Eastern Province of Zambia (Photo: B. De Waele)

Deblond). He also took the opportunity to do some extensive literature review in the museum library, before another field season in Zambia in June and July. This years fieldwork focused on a 120 km-long cross-section through the metasedimentary belt in the Shiwa N'Gandu – Ilondola Mission – Luswa River area. Various samples were taken for mineral separation and isotopic analysis, in an attempt to work out a cooling history for this section of the Irumide belt. Thin sections were prepared in Lusaka, and rock samples crushed at the Geology Department of the University of Zambia. A total of 72 samples were collected and shipped to Perth for analysis.

Outcomes: During 2001, this project has generated one publication (TSRC Publ. #155) and six conference proceedings.

Aims for 2002:

Fieldwork in 2002 by Mr De Waele will focus on the central and southwestern part of the Irumide belt, and sections will be mapped through the metasedimentary Muva Supergroup in the Katibunga Mission and Mkushi-Serenje-Chisomo areas. Analytical work will focus on mineral separates from samples collected in previous years, and selected samples will be dated using SHRIMP, Ar-Ar, Rb-Sr and Sm-Nd techniques. Further geochemical analyses will be undertaken to define better the different magmatic units in the belt, and mineral compositions in selected samples will be analysed by scanning electron microprobe to calculate pressure-temperature conditions of metamorphism, which in conjunction with the isotope data, will help to constrain their cooling history.

Zircons from the Chongwe-Chiawa area are currently being separated for SHRIMP analyses and peak metamorphic rutiles are ready for dating by TIMS and ICP-MS. To integrate the timing of high-pressure metamorphism with the metasomatic and petrological evolution, inclusions in dated zircons will be examined using Raman spectroscopy.

Zircons from the Eastern Province are ready for geochronological analyses, at Memorial University, Newfoundland, scheduled for early 2002.

Participants: Mr B. De Waele, Drs I. Fitzsimons, S. Johnson, and M.T.D. Wingate, with Mr C. Katongo and Dr F. Tembo (University of Zambia), Dr B. Mapani (University of Zimbabwe), Dr T. Rivers (Memorial University, Canada) and the cooperation of the Geology Department at the University of Zambia. Preliminary work was co-funded by IGCP 418.

Project 2.2.2: Tectonic profile through Madagascar

Aims:

Madagascar holds a critical position in Gondwana reconstructions, lying between the African and Indian cratons that collided to produce the East African Orogen as the intervening Mozambique Ocean was subducted during the late Neoproterozoic. The East African Orogen represents the culmination of the transformation from Rodinia to Gondwana, but it remains relatively poorly understood with little consensus on the time of collision or the precise location of the suture that separates crust of essentially African origin from that of Indian origin. Madagascar provides probably the best-preserved section through the eastern margin of this broad orogenic zone, and preliminary data suggest that geological relationships on this island could hold the key to the evolution of the orogen as a whole. This project aims to construct a tectonic profile through the Neoproterozoic basement rocks of Madagascar, as part of the broader aim of the parent project (2.2), which is to complete a continuous section from the Bangewelu Craton of Zambia to the Dharwar Craton of India.

Progress:

Fieldwork in 2001 focused on the Itremo Group of central Madagascar, a multiply deformed and metamorphosed series of quartzite, marble and micaschist. Dr Simon Johnson and Honours student Jenny Abello conducted a 20 km transect through the Ambatofinandrahana region, where relationships between the metasedimentary country rocks and ca. 790 Ma Itsindro Gabbro indicate that early recumbent folds in the Itremo Group were present before the gabbro was emplaced. Abundant andalusite relics within the contact aureole of the gabbro confirm that it was emplaced at shallow depths. These