

+MgO between 4.5-7.5 which together with REE patterns that show significant Eu-anomalies, moderate LREE enrichment and absence of HREE depletion are typical for various Phanerozoic active margin settings (Mc. Lennan and Taylor, 1991). In La-Th-Sr discrimination diagrams they are located in the continental island arc field. Therefore geochemistry and metamorphic peak age are prime evidence of the existence of an active margin prior to the Famatinian collision and do not support the idea of a passive margin evolution for the entire Conlara Formation.

### BTH 73 Wooden, J. L.

#### PROVENANCE OF THE EOCENE TYEE FORMATION AND RELATED SANDSTONES, WESTERN OREGON AND WASHINGTON: DETRITAL ZIRCON EVIDENCE

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U-Pb ages have been determined with SHRIMP ion microprobes for 50-70 detrital zircons from each of 4 Eocene sandstones in the Coast Range. Two samples are from the middle Eocene turbidites of the Tyee formation; one SW of Roseburg, OR and one west of Corvallis, OR. The northernmost sample of the Tyee is west of Portland and interbedded in the upper part of the basalt of Hembre Ridge, a middle Eocene oceanic pillow basalt sequence. The fourth sandstone is from the Blue Mountain unit that is interbedded with basaltic submarine lavas and breccias of the Crescent formation, NE Olympic Mtns., WA. The age spectrum for the Oregon samples is very similar (25-35% Eocene, 30-40% Mesozoic, 25-45% Precambrian), and a common provenance is indicated. The Olympic Mtns. sample is different: 75% Mesozoic, 5% Eocene, 10% each middle-late Paleozoic and Proterozoic. The Eocene grains are restricted to 45-54 Ma, and Mesozoic grains are 60-70% Cretaceous with the rest Jurassic. Precambrian grains in all samples are dominantly 1.3-1.4 Ga and 1.6-1.8 Ga, but 5 Archaean grains were identified. Zircon morphologies are consistent with the immature mineralogy of the sandstones. Previous studies of the Tyee utilizing geologic and isotopic data have argued for a provenance in the Idaho batholith region, with drainage entering the depositional basin from the south. The U-Pb zircon data are consistent with this conclusion and with the paleomagnetic evidence for clockwise rotation, but little or no translation, of the Coast Range terranes, although some inconsistencies remain. Other possible provenance regions in western North America are poor fits to the data. The Olympic Mtns. sample clearly has a different provenance that is consistent with more 'local', and/or more northerly, sources dominated by Mesozoic rocks such as the Okanogan region of north-central WA. Some of the Eocene grains in these samples may have been locally derived from silicic volcanics of the Coast Ranges, as demonstrated by on-going SHRIMP investigations.

### BTH 74 DeGraaff, Kathleen A.

#### EMPIRICAL EVALUATION OF DETRITAL ZIRCON SYSTEMATICS IN FLUVIAL AND TURBIDITE DEPOSITIONAL SYSTEMS

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Detrital zircon ages integrated with sedimentologic and tectonic analysis constitute a powerful tool for sediment provenance determination and have the potential to unravel complex depositional histories. The relatively new application of detrital zircon analysis to large-scale tectonic problems has generated significant controversy, in part because the approach lacks a well-defined methodology. Currently, there is little understanding of detrital zircon systematics and the potential biases inherent in detrital zircon provenance analysis. Provenance results may be influenced by sediment transport mechanisms, depositional setting, and detrital zircon sampling, separation, and analysis methods. This study will examine how detrital zircon age spectra vary within a single depositional system and how many samples are required to adequately characterize the detrital zircon age spectrum of a sedimentary formation for provenance determination. The results of this study will provide baseline data for the detrital zircon method, thereby improving our understanding of detrital zircon systematics, providing a sampling protocol for detrital zircon provenance studies, and guiding detrital zircon provenance interpretation.

To test how depositional setting affects sediment dispersal and detrital zircon populations, we examined the age variation of detrital zircon populations in the Methow Basin of north-central Washington. In the Methow Basin, an east-derived turbidite sequence comprising the Harts Pass Formation is overlain by east-derived fluvial sands of the Winthrop Formation. SHRIMP U-Pb age results suggest that the detrital zircon populations are quite variable in the fluvial Winthrop Formation and relatively homogeneous throughout the thickness of the turbiditic Harts Pass Formation. The greater variation apparent in the Winthrop Formation may reflect differences in catchment size and sediment mixing between fluvial and turbidite systems. These results indicate that the distribution of detrital zircon populations in the Methow Basin is not independent of depositional setting. We are currently applying this approach to the Great Valley Sequence of California to improve our understanding of detrital zircon systematics and provide a context for interpreting detrital zircon provenance data.

### BTH 75 Barth, Andrew P.

#### DETRITAL ZIRCON GEOCHRONOLOGY OF PROTEROZOIC QUARTZITES FROM THE WESTERN MOJAVE PROVINCE

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Detrital zircon geochronology from Proterozoic quartzites exposed in the westernmost Mojave Province of the US indicate a variety of sediment sources that changed significantly throughout the evolution of the continental margin. Early quartzites are dominated by homogeneous zircon populations most likely derived from local sources, whereas Late Proterozoic quartzites have diverse zircon populations that are not consistent with a southwest US source. The data permit correlation between Proterozoic rocks exposed in the San Bernardino and Pinto Mountains structural blocks.

We report SHRIMP ages for zircons from the Wildhorse and Grinnell Mountain quartzites in the San Bernardino Mountains and two quartzites from the Pinto Mountains. The Grinnell and Pinto Mountain quartzites are dominated by euhedral zircons ranging in age from 1600 to 1800 Ma with a peak at 1700 to 1750 Ma. These quartzites also include minor Early Proterozoic and Archaean zircon components (2200 to 3500 Ma). All zircons from these samples could be derived from locally exposed plutons, ortho- and paragneisses. The lack of grains younger than 1600 Ma suggests deposition of Grinnell and Pinto Mountain quartzites prior to extensive magmatism at 1450 Ma. Furthermore, the similarity in zircon populations from across the San Bernardino and Pinto Mountain blocks suggests a previously unrecognized correlation between Precambrian rocks in these areas. Data for

two samples from the Wildhorse quartzite show major populations at 1150 to 1300 Ma with a peak at 1200 to 1250 Ma, and at 1350 to 1500 Ma with a peak at 1400 to 1450 Ma. The next significant group is 1750 to 1900 Ma with a peak at 1870 Ma. Archaean zircons are poorly represented. This age distribution is not expected if the southwest US was the source. Consequently, we suggest a nonlocal source, perhaps the rifted margin of Rodinia. This interpretation is consistent with paleocurrent analysis for the Wildhorse quartzite that indicates a source from the (present-day) south and west.

### BTH76 Espinosa, G.

#### ISOTOPIC EVIDENCE ON THE PROVENANCE OF THE LOWER CAMBRIAN WOOD CANYON FORMATION, SOUTHERN CALIFORNIA

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Nd isotopic data have been obtained from shales, siltstones and sandstones from the Lower Cambrian Wood Canyon Formation (WCF) in southeastern California to assess their provenance and to constrain models for Neoproterozoic to Early Cambrian uplift and subsidence of the rifted western margin of Laurentia. In the cratonal Marble Mountains locality, the middle member of the WCF nonconformably overlies Proterozoic rocks. Both coarse and fine-grained samples at the base of the unit have low measured eNd values (-18.2 to 20.6), consistent with their derivation from erosion of the underlying Mojavia granitic basement. Higher in the section (7-108 m from base), sandstones also have low eNd (-16.2) but siltstones in both the middle and upper members of the WCF have higher eNd values (-7.6 to 9.7). Combined with paleocurrent data suggesting a WNW directed fluvial transport for the WCF in this location, the Nd data suggest that fine-grained sediments were derived from more distal crustal sources in Nd Province 2-3 (ie. Arizona or points farther east). To the west, in the San Bernardino Mtns., phyllites assigned to Wood Canyon Formation (Cameron, PhD thesis MIT, 1981) also have high measured eNd values (-8.4 to 9.3) and Nd model ages ranging from 1.4 to 1.8 Ga. These data generally support models in which extensive westerly directed drainage systems in southern Laurentia during the Early Cambrian provided fine-grained detritus to the continental margin, but local areas of positive relief nearer the margin itself provided coarser detritus. None of the analyzed were similar isotopically to high eNd arkosic material (-3 to 4) found in miogeoclinal portions of the middle WCF in southern Nevada (Farmer and Ball, GSA Bull., 1997) which were interpreted to have been derived from a local 1.0 Ga granitic source. Detrital zircon U-Pb studies of the WCF in SE California are underway to further assess whether 1.0 Ga rocks were unimportant as sources of the WCF in this region.

### BTH 77 Van Schmus, W. R.

#### AGES OF DETRITAL ZIRCON POPULATIONS FROM NEOPROTEROZOIC SUPRACRUSTAL UNITS IN NE BRAZIL: IMPLICATIONS FOR ASSEMBLY OF WEST GONDWANALAND

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U-Pb ages have been determined for detrital zircon populations from metasedimentary units in the 600 Ma Borborema structural province of NE Brazil using the ANU SHRIMP. The units represent metaclastic sequences in regional fold belts that were previously inferred to have depositional ages ranging from ca. 2000 Ma to 750 Ma. Our data resolve the ages of these units and place them into a tectonic framework ranging from 1000 Ma to 600 Ma that is consistent with recent advances in understanding the tectonic history of the province. Combined use of Sm-Nd model ages (TDM) also helps define the nature of the source terranes.

The samples fall into three types: those with (a) mostly Paleoproterozoic zircons, (b) mostly 1000 Ma zircons +/- Mesoproterozoic to Archaean zircons, and (c) mostly 640 to 1000 Ma zircons. Type (a) occurs in basal units of basins, has old TDM ages (>2 Ga) and reflects local Paleoproterozoic basement. Type (b) is from metaturbidites associated with the ca. 970 Ma Cariris Velhos orogeny and represents syn-volcanic flysch deposits. It has TDM ages of 1.4 to 1.6 Ga that mimic the TDM ages of nearby Cariris Velhos continental arc rocks, which are presumed to be the dominant source. Type (c) represents late

Neoproterozoic clastic basins that are no older than 650 Ma. They may be as young as 630 Ma, but must predate the 600 +/- 10 Ma Brasiliano-Pan African continental collisions which deformed them. These units are presumed by some workers to be Paleoproterozoic, but the new SHRIMP data, along with TDM ages of 1.2 to 1.6 Ga, preclude such an interpretation. These units may represent pre-collisional flysch basins, although no proximal source of the graywacke detritus has been identified yet; the sediment may have been derived by lateral transport from pre-collisional terranes elsewhere in the Brasiliano-Pan African orogen of West Gondwanaland.

### BTH 78 Mathur, Ryan

#### RE-OS INVESTIGATION OF THE CANDELARIA MINE, CHILE

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The source and timing of mineralization of the ores in the Candelaria mine are two important, yet poorly understood questions. In this study, the Re-Os isotopic system is used to provide insight to these fundamental problems. The mineralization at Candelaria consists of magnetite, hematite, chalcopyrite, pyrite, and gold occurring in veins, breccia fillings, and disseminations. There has been no distinct igneous source for this mineralization, or definite alteration patterns. Proposed models for ore deposition range from submarine volcanogenic massive sulfides to deep-seated porphyry like magmatic emplacement.

Previous studies produced 40Ar/39Ar ages between 114-116Ma that suggest alteration occurred during the emplacement of the Punta Del Cobre batholith since Ar ages of this batholith range from 119-97Ma. In this study, the Re-Os isotopic compositions of chalcopyrite+pyrite, and magnetite+hematite separates were analyzed to constrain when mineralization occurred, and where the ore forming elements originated.

Magnetite+hematite and chalcopyrite+pyrite separates from one hand sample have Re concentrations ranging from 0.350-4.8ppb, and Os concentrations ranging from 0.008-0.019ppb. The isotopic ratios of 187Re/188Os varied from 242-1702, and 187Os/188Os from 0.77-3.12. These preliminary data form two linear trends on an isochron diagram. The chalcopyrite+pyrite separates plot an 'isochron' with an age of 112±3Ma, and initial of 0.34, whereas two magnetite samples form a line with an initial of 0.61, and a slope

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