and sediment filled arid basins straddling this plateau are ephemeral. The relations between deformation, uplift, basin formation, and climate are illustrated well in the Quebrada del Toro at about 24° S in the Cordillera Oriental. The basin records the transition from a foreland to a broken foreland setting with range uplift beginning after about 8 Ma. Deformed sediments are overlain by about 1000-m-thick, poorly lithified conglomerates; in the lower 200 m of the section they laterally grade into plant-bearing lake deposits indicating a humid environment similar to the eastern windward slopes of the present basin border. Conglomerate deposition began after 8 Ma following deformation but before deposition of a 4.17 Ma tuff in the lower part of the sequence and continued until 0.98 Ma, when renewed thrusting along the basin margins and within the basin deformed these strata. These deposits were incised to elevations comparable to the present base level, suggesting integration of the Toro basin into the foreland drainage system. However, this event was superseded by a second, important influx of conglomerates, which filled the pre-existing erosional paleotopography to levels that are up to 700 m above the present trunk stream. Subsequently, these conglomerates and all older units were extensively stripped and incised again to the present local base-level. Incision was episodic as documented by five inset strath terraces that follow the course of the trunk stream. Mapping of the Quaternary deposits and DEM analysis indicate that a minimum of 61.5 km^3 of material was removed from the basin during the Pleistocene. The average elevation change within the Quebrada del Toro is 158 m, which corresponds to 0.158 mm/yr of exhumation within the ultimate 1 Ma. This exhumation rate appears to be far lower than regional minimum rock uplift rates. Therefore, the basin surface was, and continues to be uplifted, which may be coupled with continuing uplift of the adjacent Puna Plateau. Unlike the margin of the northeastern Tibetan Plateau, where continued thrusting creates intramontane basins that are being filled with sediments that are ultimately incorporated into the plateau realm, the Toro basin is clearly transitory. Identical histories exist in other basins along the Puna edge. In contrast to basins with similar geometries in the arid Puna the basins straddling the eastern plateau margin cannot be sustained as depocenters and closed basins due to a very effective erosional regime of a wetter climate acting on the basin margins. This leads to large rainfall gradients in this area with easterly moisture sources, headward erosion, drainage capture, and ultimately basin exhumation.

T32E-05 1700h

Shallow Seismic Reflection Imaging of the Salar de Uyuni, Bolivia: Quaternary Neotectonics and Stratigraphy

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Results from a shallow seismic reflection experiment in 2000 on the Salar de Uyuni at the southern end of the Bolivian Altiplano will be presented. This salar is the largest salt flat in the world (130 km x 80 km) and is a remnant of the Quaternary paleolake Minchin/Tauca. Paleoshorelines of this lake mapped by GPS show marked deformation (Bills et al., GRL, 1994). The salar also shows evidence for both Quaternary volcanic activity and active faulting from Andean tectonics. The paleolake stratigraphy of the salar, therefore, may record neotectonic deformation from three different processes: (1) isostatic rebound from the evaporation of the deep lakes that have occupied this region periodically during Quaternary climate fluctuations, (2) active faulting along local/regional fault systems, and (3) regional uplift and/or tilting of the Andes. The seismic experiment was designed, in part, to determine the extent to which the Quaternary lake stratigraphy documents neotectonic deformation and, if possible, to separate the effects of the different processes. The seismic profiles were collected using IRIS PASSCAL instruments and a hammer source. The stratigraphy is imaged to a depth of at least 200 m at surprisingly high frequencies and can be tied to the 220 m deep paleoclimate corehole drilled by Baker et al. (Nature, 2001). One 130-km transect was collected across the entire E-W width of the salar. A second 50-km N-S transect crosses at the corehole. These profiles are limited by very low spatial sampling but clearly show that the shallow Quaternary lake deposits now dip to the east and north and are offset by sets of faults, particularly on the eastern side of the salar. The tilting of the stratigraphy conforms with the thickening of the young surficial salt layer to the east, although the shallowmost seismic data quality doesn't allow one to determine the youngest age of layers offset by the imaged faults. Current efforts are to separate out the isostatic rebound signature from the deformation from faulting.

T32E-06 1715h

Late Cenozoic tectonics of the Coastal Cordillera of N Chile and implications for paleoclimate and interplate processes

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The Coastal Cordillera of northern Chile is located in the hyperarid Atacama Desert and is situated over the interplate seismic zone of the Nazca-South America convergent plate boundary. The Coastal Cordillera is bounded to the west by a 1000 m high escarpment that plunges directly to the sea north of Iquique but to the south has a 1-5 km wide Pleistocene abrasion platform at its base. We use a 20 m InSAR digital elevation model (DEM) combined with fieldwork to investigate the relations between the late Cenozoic tectonics and drainage development in the Cordillera between the Río Loa (21.6S) and the Quebrada de Camarones (19S). Late Cenozoic structures in this region consist of EW striking reverse faults and NS striking normal faults. The primary development of the reverse faults occurred in the Miocene and early Pliocene, though warped Pleistocene marine terraces indicate some later reactivation. These structures produce about 1% shortening parallel to, and appear to be related to the seaward concave curvature of, the plate boundary. Late Miocene to Recent normal faults throughout the Coastal Cordillera parallel the plate boundary and dip both towards and away from the trench. At several places in the study area, paleodrainages were incised across the uplifting EW reverse fault blocks prior to being dammed, producing internally drained evaporite basins in the footwalls of the structures. These relations indicate that there was considerably more water in the Coastal Cordillera in the latest Miocene and early Pliocene than is available at present, in agreement with the prior suggestion that the onset of hyperaridity in the region post-dates 5 Ma. The Río Loa, the only river to reach the sea along more than 500 km of coastline, truncates on of these paleodrainages indicating that the Loa was incised at its current location after the middle Miocene. The incision of the Río Loa could be due either to uplift of the Coastal Cordillera, or due to lateral (W to E) migration of its baselevel were it debouches into the ocean as the Coastal Escarpment retreats from W to E. These two processes of incision are probably controlled by underplating and subduction erosion, respectively.

T32E-07 1730h

Late Cenozoic Evolution of the Mejillones Peninsula, Northern Chile

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The Mejillones Peninsula, located on the Pacific margin of Northern Chile, contains outer shelf, shelf and coastal terrace deposits that record the paleoceanographic, tectonic, and topographic evolution of the region. Preliminary micropaleontologic, geochemical, sedimentological and geochronological analyses of sedimentary sequences within the Tiburon Basin and uplifted coastal terraces of the Mejillones Peninsula together document Plio-Pleistocene sea-level cyclicity, as well as coeval changes in marine productivity, regional uplift, and displacement on local faults. The sedimentary succession within the Tiburon Basin can be subdivided into a lower set of diatomaceous sedimentary cycles containing thin phosphatic horizons, marine vertebrates and abundant planktonic and benthic foraminifera. Preliminary analyses of these sediments indicate an initial deep-water (∼500 meter) basin with high primary productivity related to upwelling of cold intermediate water interrupted by periods of little to no sediment input. This style of deposition was interrupted by an uplift event, probably involving vertical motion on the Mejillones Fault immediately to the west of the Tiburon Basin, which dominated the character of the upper set of sedimentary cycles and comprise coarse clastic sediments including vertebrate fossils, blocks up to boulder size, interpreted as detritus from the nearby fault scarp, and well-rounded pebbles derived from the interior of the Mejillones Peninsula. This switch from diatomaceous to clastic sedimentary cycles indicates abrupt (1) shallowing of the basin to shelfal (50-100 meters) to nearshore depths, (2) generation of significant local relief on the fault scarp, and (3) large-scale uplift and erosion of the Mejillones Peninsula. An Ar/Ar age of 2.8 ± .04 Ma from an ash horizon near the top of the succession indicates a Pliocene age for the Tiburon succession, which is consistent with the foraminiferal biostratigraphy of the diatomaceous sequences. At least 10-12 coastal terraces occur within the Mejillones Peninsula, the highest of which can be traced to the margin of the Tiburon Basin and document contemporaneous subaerial exposure, uplift, and continuing sea-level cyclicity through the Quaternary.

T32E-08 1745h

Did Andean Uplift Control Climate Change in the Central Andes

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Sedimentological data indicate that a semi-arid/arid climate has prevailed across the Central Andes from over 25 Ma to 4 Ma. Between 4 and 3 Ma a marked switch to hyperaridity occurred along the western margin of South America between 10 and 27 degrees South. Palaeoaltitude data, although poorly constrained, suggest that a substantial proto-Central Andean mountain range was in place between 15 and 9 Ma. Evidence for this is provided by the presence of thick successions of evaporates developed within endorheic basins in the Altiplano/Puna area. These data support the idea that the Andean rain shadow existed by 15 Ma or earlier, and that rather than changing the pre-existing climatic regime it reinforced the already arid climate. The change to hyperaridity in western South America is attributed to a combination of global climate cooling and enhanced upwelling of the Humboldt current generated by closure of the Central American Seaway between 3.5 and 3 Ma, and did not result from the rain shadow generated by Andean orogenesis. Evidence for a global causal mechanism is seen in the Namib Desert. The switch to hyperaridity in the Namib also occurred around 3 Ma but was independent of orographic effects generated by a large mountain range.

T32F MCC: 3005 Wednesday 1600h

Orogenesis, Metamorphism, and Exhumation II *(joint with H, V)*

Presiding: **R N Pysklywec,** University of Toronto**; J Rahl,** Yale University

T32F-01 1600h

Bransfield Basin and Cordilleran Orogenesis

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Tectonic uplift of the Andean Cordillera was initiated in the mid-Cretaceous with inversion of a composite marginal basin along 7500 km of the continental margin of South America, from Peru to Tierra del Fuego and the North Scotia Ridge. In the southernmost Andes, from 50-56 degrees S, the quasi-oceanic floor of this basin is preserved in the obducted ophiolitic rocks of the Rocas Verdes (Green Rocks) basin. We suggest that the basin beneath Bransfield Strait, 61-64 degrees S, separating the South Shetland Islands from the Antarctic Peninsula, constitutes a modern analog for the Rocas Verdes basin. Marine geophysical studies of Bransfield basin have been undertaken over the past 12 years by the Institute for Geophysics, University of Texas at Austin, under the auspices of the Ocean Sciences Division and United States Antarctic Program, National Science Foundation. These studies have elucidated the structure and evolution of Bransfield basin for comparison with the Rocas Verdes basin, with a view to eventual forward modeling of the evolution of a hypothetical cordilleran orogen by compression and inversion of the basin. These are the processes that can be observed in the tectonic transformation of the Rocas Verdes basin into the southernmost Andean cordillera, as South America moved rapidly westward in an Atlantic-Indian ocean hot-spot reference frame during the mid-Cretaceous. Multi-channel reflection seismic data from the Bransfield basin reveal an asymmetric structural architecture characterized by steeply-dipping normal faults flanking the South Shetlands island arc and gently dipping listric normal faults along the Antarctic Peninsula margin. Normal fault polarity reversals appear to be related to distributed loci of magmatic activity within the basin. This architecture is remarkably similar to that deduced from field structural studies of the Rocas Verdes basin. Notably, the oceanward-dipping, low angle normal faults along the Antarctic Peninsula margin constitute ideally oriented surfaces for reactivation as thrust faults, leading to obduction of the basin floor rocks during any ensuing compressional event. Seismic refraction studies of Bransfield basin using Institute for Geophysics ocean bottom seismographs indicate along-strike northeastward thinning of the crust associated with southwestward rift propagation, comparable to that indicated for the Rocas Verdes basin by the results of U-Pb zircon dating of the ophiolitic rocks. Cross-strike segmentation of Bransfield basin also mirrors the isolated ophiolitic complexes of the inverted Rocas Basin in South America and on South Georgia Island. The results of our geophysical studies of Bransfield basin reveal close similarities in structure and evolution with the Cretaceous Rocas Verdes basin, and therefore encourage the next step of forward modeling in an effort to help elucidate fundamental cordilleran orogenic processes.

T32F-02 1615h

River transport effects on orogen development: results from a new analogue-numerical modeling technique

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Erosion, deposition and tectonic processes interact to define the style of deformation in compressional belts. We introduce a method of integrating a numerical model for surface transport with analogue models (e.g., sandbox) of compressional belts to further improve our understanding of this interplay. The analogue model provides the numerical model with the tectonic changes in topography whereas the numerical model calculates the river network and the amount of erosion and sediment transport. Compared to previous analogue models with uniform (2D) erosion, this method provides a tool to incorporate process-based rates of erosion and deposition with spatial distributions that depend on the river network developing on the evolving topography. The results show that rivers running parallel to the evolving mountain belt induce along-strike changes in erosion and deposition that in turn can result in along-strike changes in tectonic deformation. Regional isostasy, in combination with inherited relief, enhances the uneven accumulation of sediments in the foreland basin, enhancing the aforementioned effects. High erosion rates do not always lead to fewer thrusts within the compressional belts but generally steepen and lengthen the lifetime of the affected faults.

URL: http://www.geo.vu.nl/~ gard

T32F-03 1630h

Using Quantified Analogue Models to Investigate Rheology's Role in Causing Extension in Foldbelts During Convergence

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Contemporaneous margin normal compression and extension is observed in convergent margin settings. Workers have investigated this phenomenon using a single rheology and simple boundary conditions with both numerical and analogue techniques. In these experiments where a viscous rheology was used margin normal extension at the top of the wedge was observed concurrently with compression at the deformation front during active convergence. The magnitude of extension in viscous models has been directly correlated to high Argand numbers or lower viscosities. However, for similar models with viscous rheologies having low Argand numbers or with a pure frictional rheology workers have not observed margin normal extension. It has been proposed that dual rheological models may produce the geologically observed style of extensional deformation. For instance, Willet, 1999 has shown that a hybrid plastic-viscous rheology will produce extension during convergence if the viscous layer is shallow enough. Multiple rheologies have been widely used in analogue modeling but the extension observed during active convergence has not been quantified in these models. This is, in part, due to a lack of capability to accurately measure the surface strains occurring during convergence. We have developed a technique, used here, to quantify surface strains at multiple stages of the experiment, to test frictional, viscous, and frictional over viscous rheologies. In both the pure friction and viscous models our results are similar to other studies, no true extension during active convergence for friction, but significant observed rates of extension in models with pure viscous rheology. The addition of a low viscosity, or weak, basal layer results in a wedge with a small critical taper, which is predicted analytically. As dual-rheology models actively accommodate convergent strain they produce more complex deformation than either simple friction or viscous models. Hybrid models typically produce surface extension by under-stuffing. Additionally, after the succession of active convergence the viscous and hybrid models extend in areas of high topography producing additional shortening near the deformation front. In models with a sufficiently thick viscous layer a limited amount of coeval compression and extension is observed.

T32F-04 1645h

Arrest of Ultrahigh-Pressure Terranes and the Evolution of the Continental Crust

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Ultrahigh-pressure terranes can, in principle, be generated in any setting where continental crust is forced to depths greater than 100 km: i) during ophiolite emplacement onto continental margins (e.g., Oman, Timor), ii) in intracontinental convergence zones (e.g., the Hindu Kush), and iii) in continent-continent collisions (e.g., the Himalaya). The most favorable setting might be subduction of a cold microcontinent beneath a thick continental margin arc with a serpentinized mantle wedge. The infancy of field studies means, however, that the mechanisms by which most ancient ultrahigh-pressure terranes were created are unknown even to this gross level of detail. Several mechanisms for the exhumation of ultrahigh-pressure rocks have also been suggested: i) slab breakoff and wedge extrusion, ii) reversal of slab motion, iii) flow in a low-viscosity channel, and iv) diapirism. None of these models explicitly accounts for a curious feature of the three largest, well-studied ultrahigh-pressure terranes: each has a post-ultrahigh pressure metamorphic overprint of 0.8 to 1.2 GPa that almost destroyed the ultrahigh-pressure record. Why? Our combined structural, petrological, and geochronological study of the 220 km x 150 km high- to ultrahigh-pressure terrane of Norway leads us to the conclusion that early buoyancy-driven(?) exhumation through the mantle was abruptly arrested at the Moho. There, at the base of the crust, the formerly ultrahigh-pressure mass underwent vertical flattening, outward flow along the Moho, and nearly complete recrystallization. This highly modified body was subsequently exhumed through the crust, perhaps as a result of the crustal overthickening produced by its arrest at the Moho. This Moho-arrest model for the exhumation of ultrahigh-pressure terranes has significant implications for the geodynamics and geochemistry of the crust. For example, if arrested ultrahigh-pressure terranes are never exhumed through the crust and *remain at the Moho*, they replace the lower crust with variably depleted once-upper crustal lithologies. A simple calculation based on probable rates of crustal subduction at active orogenic belts suggests that this mechanism could have processed the entire lower continental crust of Earth.

T32F-05 1700h

The Role of "Dripping" Mantle Lithosphere in the Formation and Exhumation of UHP Metamorphic Crustal Rocks

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Ultrahigh-pressure metamorphism requires a rapid burial of crustal rocks to significant depth and subsequent exhumation while maintaining relatively cool deep lithospheric temperatures. The process has commonly been explained in terms of plate subduction, with the continental crust subducted to great depths and then returned within a subduction channel or as an extruding slice. Using numerical models of the thermomechanical evolution of the crust-mantle system, we investigate an alternative mechanism to account for the genesis of UHP crustal rock during continental collision. The numerical experiments show that in the early stages of collision, packages of lower crustal material are entrained to depth into a thickened mantle lithosphere root beneath the young model orogen. Subsequently, the mantle lithosphere root "drips" into the mantle as a Rayleigh-Taylor-type gravitational instability. This results in partial uplift of the buried crust, as the buoyant material separates from the descending root and rises. Late stage exhumation of the crust to the surface occurs more slowly, related to exhumational processes operating within the still active collisional orogen. The P-T evolution of the buried crust is tracked in the experiments and we find its history is consistent with those observed for UHP metamorphism. We propose this model of burial and uplift of crustal material encased in an unstable mantle lithosphere root during young, cold continental plate collision as an alternative to traditional subduction models of UHP crustal burial. The mantle drip model is consistent with a number of geological observables of UHP rocks in continental collision zones and may have several favourable features over a subduction channel/extruding slice models.

T32F-06 1715h

Exhumation of Norwegian Ultrahigh-Pressure Rocks: Zircon Geochronology and Tectonostratigraphy of the Hornelen Region

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The Norwegian UHP province is thought to have been exhumed in the footwall of the Nordfjord-Sogn Detachment Zone (NSDZ). However, the presence of high pressure eclogites in the both the hanging wall and footwall, in addition to a lower-crustal supra-Barrovian overprint observed across the Western Gneiss Complex, suggest that the NSDZ exhumed rocks from lower-crustal levels, but not from UHP depths. In order to fully understand the significance of the NSDZ and the extent to which it was responsible for the exhumation of the Norwegian UHP provinces, we must describe the kinematic evolution of the NSDZ, as well as the regional deformation prior to the onset of extension. Here, we employ zircon geochronology as a tool to differentiate key tectonostratigraphic units, characterize the various stages of deformation, and determine the time of deposition in extension-related basins. In the Hornelen region, the NSDZ consists of a 2-6 km thick section of pervasively top-W sheared allochthonous rocks that separate an eclogite-bearing footwall from low-grade Devonian sedimentary basins. Previous mapping divided the allochthons into two tectonostratigraphic units: Dalsfjord Suite orthogneisses overlain by Høyvik Group paragneisses. We used zircon geochronology to unravel the complex deformation of these two units: detrital zircons from Høyvik Group quartzites yielded two distinct age populations of 1100 and 1600 Ma while Dalsfjord Suite crystalline gneisses and schists gave single zircon age populations between 1600 and 1700 Ma. These zircon age populations support new field observations that indicate that the Høyvik Group and Dalsfjord Suite represent a basement-cover unconformity that was isoclinally folded into E-vergent map-scale nappes during early contraction. Thermobarometry on coarse garnet-muscovite schists across the region indicates tectonic burial to peak pressures of 12-17 kb and 550-625 C. During late stage orogenic collapse, these nappe structures were rotated and transposed parallel to the stretching direction as the region experienced widespread extension and the Devonian Basins opened. The Devonian sedimentary basins are much less deformed than the underlying allochthons. Distal sandstones from the western Hornelen Basin yielded three distinct zircon age populations of 420, 1200 and 1700 Ma, while proximal conglomerate matrix from the eastern Hornelen Basin yielded two distinct zircon age populations of 1700 and 1000 Ma. The presence of 420 Ma zircons within the basins indicates that Caledonian metamorphic rocks must have been exhumed prior to the opening of the extensional basins.

T32F-07 1730h

Two-stage exhumation history of Miocene high-pressure, low-temperature rocks from the footwall of the Cretan detachment fault, Crete, Greece

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The island of Crete represents an emergent fore-arc high in the modern Hellenic subduction zone. The island exposes high-pressure, low-temperature metamorphic rocks (maximum P-T conditions estimated at 1 GPa, >250 C) juxtaposed against unmetamorphosed rocks by the Cretan detachment fault, a major structure that excises at least 20 km of structural section. We present new zircon (U-Th)/He data to constrain the cooling and exhumation history of the high-pressure metamorphic rocks. Additionally, we combine new stratigraphic and microstructural observations with a review of previously published thermochronologic data to create a revised interpretation of the P-T-t evolution of the lower plate. Stratigraphic constraints require that the metasediments of the lower plate were deeply subducted sometime after 36 to 32 Ma. White mica Ar-Ar ages, interpreted here as sub-closure crystallization ages, suggest peak metamorphic conditions were reached between 24 and 20 Ma. Previously published zircon He ages reveal cooling through 240 C at about 18 Ma. Our new zircon He ages show that the lower plate rocks cooled below 210 C around 10 Ma. Finally, conglomeratic deposits indicate exposure of the HP rocks at the surface at about 8.5 Ma. Exhumation rates are estimated using a one-dimensional thermal model to account for advection of isotherms and the Dodson relationship to account for the effect of cooling rate on effective closure temperature. This analysis indicates an exhumation rate of 0.7 km/m.y. during 18 to 10 Ma, followed by faster exhumation, at about 2 km/m.y., between 10 and 8.5 Ma. These rates are much smaller than previous estimates by Thomson et al. (1998) of sustained rates of 4 km/m.y. We use these results to constrain the rate of slip on the Cretan detachment, which is widely considered to have formed as a low-angle normal fault. Previous workers have argued that, given its low dip, slip on the Cretan detachment must have been 20 to 30 km/m.y., which is approaching the modern convergence rates estimated for the Hellenic subduction zone that underlies Crete (40 km/m.y.). This conclusion is in contrast to fault slip rates determined from studies of the metamorphic core complexes of the Basin and Range province, which typically are 3 to 8 km/m.y. and generally no more than 10 km/m.y. Our results indicate much slower slip rates for the Cretan detachment. Assuming that exhumation is entirely due to slip on a low angle detachment, we estimate that the slip rate was about 1.5 km/m.y. from 18 to 10 Ma, and about 4 km/m.y. after 10 Ma.

T32F-08 1745h

On-Going Regional Metamorphism Under the Japanese Islands

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Combining the phase diagrams of MORB + water, pelitic-psammitic rocks, and of peridotite + water, with thermal structure of the descending slabs of the Pacific in NE Japan and Philippine Sea (PHS) in SW Japan, and with velocity structure of sub-arc mantle, we can draw the metamorphic facies distribution of regional metamorphism, water circulation under the Japanese islands and small-scale mantle convection in the wedge mantle. The most uncertain parameter is a thermal structure calculated by numerical simulation, because of difficulty of evaluation of frictional heating, heat transportation by dehydration and mantle convection in the hanging wall. To overcome this problem, the direct seismic determination of the depth of blueschist-eclogite transformation (50-60km depth in the Pacific slab), seismogenic zone (150°C to 350°C), depth limit of tremor seismicity (Obara, 2002, dehydration limit at 40km depth, ca.500°C) slab melting in SW Japan (750-800°C at 80km depth) were used as fixed temperatures. Moreover, the thickness of Pacific MORB crust (6km) and overlying sedimentary mass (3km), Moho depth and shape of wedge mantle in both SW and NE Japan were used through the recent seismic investigations. Under the NE Japan arc, the MORB crust on the descending Pacific slab is regionally metamorphosed at 50-60km depth ca. 550°C from blueschist to amphibole eclogite to release 1.5 wt% water by the discontinuous reaction. The complex dehydration reaction of dense-hydrous silicates including antigorite occur at depths ca.200-180km from which water-rich fluids penetrate upwards into dry eclogite where it may be partially melted to form felsic magma. It may react to generate pyroxenite in the mantle wedge and become a rising wet column to cause arc magmatism as documented by the high-resolution P-wave tomographic images (Zhao et al., 1992). On the other hand, the low-T (ca.550°C) wet rising column at 50-60 km depth right above the Pacific slab hydrates the hanging wall. The two rising wet columns merge at Moho below the arc-trench gap to form a dowelling flow. The small-scale convection cell in the wedge mantle at shallow depth <200km may preserve the 3 km thick felsic regional metamorphic belt at depth range from 70-80km to 50km on the downgoing Pacific slab. On the other hand, the active volcanoes are rare in SW Japan and dip of subducting PHS plate is small, a thin wedge mantle is hydrated extensively in the oceanward half, but not in the continental side. The possible presence of thin (ca.2km) felsic materials on the PHS slab may exhume as a plastic flow against the subducting PHS slab (4cm/y) due to the small-scale corner flow in the wedge mantle.

T41A MCC: 2002-2004 Thursday 0800h

At the Seismogenic Front: Dynamic Processes at Convergent Margins I

(joint with G, S)

Presiding: **H Tobin,** New Mexico Institute of Technology**; K Ujiie,** IFREE/Japan Marine Science and Technology Center

T41A-01 0800h

What can old Rocks Tell us About the Upper Aseismic to Seismic Transition in Subduction Zones?

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At subduction zones the upper aseismic transition occurs at 5 - 15 km and at modeled temperatures of 100 to 150 deg. C. Combined studies of the structural and thermal history of subduction complexes thus allow placing rocks above or below this transition. Rocks deformed at temperatures less than 125 deg. C show an array of mesoscopically ductile and compactive deformational features that are associated with loss of intergranular fluid. Deformation zones dewater, expand into adjacent less consolidated sediment, producing intervals of stratal disruption. Stratal disruption is commonly accommodated by cataclastic shear zones or “deformation bands”. Clays dominate shear zones. Such distributed deformational features and clay-dominated shear zones probably are velocity strengthening and not seismogenic. Rocks deformed at temperatures greater than 125 deg. C show overprinting of the earlier deformational features by pressure solution, with abundant precipitation of solutes as veining and cements, dominantly as calcite and quartz. Later generations of veins become cleaner with less included particulates, reflecting lithification. Cycles of cataclasis, pressure solution and precipitation repeatedly occur. As temperatures rise into the 200 degree level quartz becomes more dominant over calcite. Quartz coats and cuts across shear zones. Quartz is known to be velocity weakening; its widespread mobility and presence on and across shear surfaces at temperatures correlated to seismogenic depths suggests it may be a major factor in seismic instability. In SW Japan, an example of such repeatedly cataclastized, pressure solved rock develops pseudotachylyte, indicating seismogenic behavior. Precipitates heal fault zones that would allow fluid pressures to rise and trigger fault displacement. Studies of fluid inclusions in quartz veins suggest cyclical variations in fluid pressures although the interpretation of these results is controversial.

T41A-02 0815h

A Comparative Study on Exhumed Seismogenic Faults and Modern Nankai Seismogenic Megathrust

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One of the critical questions to understanding the seismogenic subduction zone is what controls the updip limit of the zone. The question is quite significant to address why the rupture zone stops in some case or propagates to shallow portion and results in the tsunamigenesis in another case. The Nankai trough is a single most unique subduction zone in the world, where historical repetition of large earthquakes and tsumani more than 700 years are well recorded and the updip limit is located enough shallow to drill by riser vessel. That is one of the reasons why drilling into the seismogenic plate boundary has been proposed in the Nankai Trough. Before drilling, we are conducting a comparative research on exhumed seismogenic fault in ancient accretionary complex on land, which was once located in the seismogenic depth, and the modern Nankai Trough of targeted site for drilling. Several new findings from the exhumed rocks stimulate the understanding of the sesimogenic zone and sharpen the targets by drilling. 1. Break and involvement of oceanic basement into the accretionary complex as blocks of melange is suggested to be a seismic process because of ubiquitous brittle (cataclastic to ultracataclastic) breakage of the oceanic fragment in contrast to ductile deformation of underthrusted sediments. 2. A boundary fault such as sandstone dominated coherent unit (might be off-scraped) and mudstone dominated chaotic one (might be underthrusted) is a clear seismogenic fault and a candidate for a major seismogenic plate boundary. A discovery of pseudotachyllyte from the fault strongly suggests a melting lubrication for rupture propagation around the updip limit of the sesimogenic zone. 3. Detailed analysis of the melange and the boundary fault suggests a repeated activity of pressure solution creep (interseismic) alternated with cataclastic or melting slip (coseismic) in a thick plate boundary zone. 4. Crack seal mineral veins are also developed in and around the fault. P-T condition from H2O-CH4 fluid inclusions and vitrinite reflectance suggests the development of the veins within the seismogenic zone. Vein development especially within the fault and shale dominated part below the fault suggests the place where dehydrated fluid pool and pathway is strongly controlled by structural and lithological setting. These geologic aspects suggest the plate boundary fault around the updip limit of the seismogenic zone, which is imagined from strong reflectors on the seismic profile and is a significant target of IODP (NantroSEIZE proponents).

T41A-03 0830h

Overpressures and Lithification State of Underthrust Sediments Along the Nankai Accretionary Margin: Implications for Décollement Evolution

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