and Lu/Hf greater than the MORB source, and with time, Talkeetna lower crust should evolve to isotope ratios more depleted than the MORB source. Anatexis of garnet-bearing lower crustal rocks will produce isotopically depleted, light REE enriched, heavy REE depleted partial melts. Interaction of these granitic melts with surrounding mantle peridotite will raise their Mg# and Ni, and lower SiO_2 to produce andesitic or basaltic hybrid magmas. Moho temperatures in the western Aleutian arc may be relatively low, below 900°C, due to slow convergence and low magma flux, enhancing formation of garnet granulite and subsequent delamination. Lower arc crust formed during early Aleutian magmatism, with the isotopic composition of MORB at 40 Ma and trace element patterns of Talkeetna pyroxenites and garnet granulites, will evolve to yield isotope ratios like those of Miocene and present day Aleutian andesites. Thus, melting of delaminated garnet granulites within the mantle wedge may be a viable alternative to partial melting of subducted eclogite, producing the light REE enriched, heavy REE depleted component in western Aleutian primitive andesites. Tectonic erosion of old arc basement from forearcs, and incorporation of these rocks into the mantle wedge, might have similar consequences.

V41A-03 0830h

4D constraints on melt source-rock input and granite production in continent-continent collision; a case study from a 50 km wide swath through the Himalayan magmatic arc

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Detailed mapping, mountaineering and high resolution remote-sensing data from the Bhutan High Himalaya illustrate rates & / volumes of magmatic arc growth in continent-continent collsion. Lunana & Gonto La, a 20 km x 30 km area with >3 km relief, provide 3D data for widespread, km-long, Dm-thick, sill- & laccolith-form leucogranites. These peak-forming (>8000 m) Miocene plutons are typical for the ca.2500 km magmatic arc of the India-Asia continental collision. Extrapolation to geo-traverses through peaks to the east (Khula Kangri, Monlakarchung) onto a 30sec DEM provide tight datapoint 3D subsurface control for >4500 km^3, thereby constraining total pluton shapes and volumes. Geochemistry studies indicate exclusively decomposition melting (Harris, et al. 2002) and permit us to calculate required melt-source rock volumes for various conditions. Project INDEPTH seismic reflection profiling (conducted imm. to the N. - Nelson et al. 1996) has been used with further mapping to obtain a 50 km wide, 150 km long swath through the entire orogen. These reveal the sub-surface form of the shallow, gently N-ward dipping, crystalline, mid-crustal layer that is exposed at the High-Himalaya, the upper part of which the plutons intrude. The 4D part of our 3D swath through the magmatic arc is geochronology for the plutons and, to the north, of local granitoid protrusions from beneath the cover rocks of the melted mid-crustal layer that constrain a N-ward younging of plutonism (Copeland 1990; Edwards & Harrison 1997; Edwards et al. 1998; Li et al. 1998). Using these time constraints together with a kinematic model incorporating dilatant flow where both lines of no-rotation are stretching and non-parallel to shearing boundaries, we link deformation with melt source-rock magmatic product volume changes. We derive a timetable for melt addition and thereby rates of magma extraction and ascent.

V41A-04 0845h INVITED

Rifting, Insertial Magmatism And Continental Arc Construction, Peru

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The Mesozoic-Cenozoic tectonic evolution of the Peruvian continental margin of South America is dominated by periods of intracontinental rifting and basin formation. The Andean cycle in this region starts in the Cretaceous with intrusion of the tonalite-dominated Coastal Batholith (CB) into an Albian marine basin forming part of a major extensional system extending from Columbia to the Antarctic. Basaltic material at the bottom of the basin was remelted to produce mainly tonalitic magmas of the CB, which were intruded vertically up axial fractures to form thin, trench-parallel, horizontal intrusions near the surface. Gravity modelling of the CB and its envelope shows the intrusion is tabular, with an aspect ratio close to 20. Individual plutons have aspect ratios close to 5. A thick (10-km) root zone to the west is interpreted as a multiple dyke feeder system. It is likely that much of the CB was intruded under a shallow sea that covered the basinal rocks prior to inversion. From Eocene times onwards, volcanism and plutonism migrated inboard, culminating in the intrusion of the Cordillera Blanca Batholith (CBB) and Yungay ignimbrites at c. 6 Ma. Situated above the now thickened crustal root of the Andes (c. 60 km), the CBB was intruded into Jurassic basinal shales which form part of the much larger West Pervian Trough, and its emplacement overlaps with intense uplift and exhumation along the Andean margin at c. 15-10 Ma. The western margin of the basin and CBB terminate at the Cordillera Blanca fault complex, a deeply disecting, trench-parallel crustal lineament. In contrast to traditional models of cordilleran magmatism, which often predict 'S'-type magmas inboard of the main arc, the CBB rocks are high Na, high Sr/Y types similar to Archean trondhjemites that contrast markedly with the calc-alkaline magmas of the CB. Similar calc-alkaline to adakite-like compositional trends are seen in spatially related volcanic rocks in land from the trench. In the Peru arc, the generation of large volumes of granitic (s.l.) melts is related to periods of crustal extension, with the pre-existing (Gondwana) structural template of the continental margin controlling both location and style of intrusion. The source material for the majority of plutonic rocks was newly generated basaltic lower crust. Volume constraints imply that the crustal column beneath the western Peruvian arc evolved significantly from c. 20 to 5 Ma, with vertical thickening driven by an elevated flux of mantle-derived magma into the lower crust, followed by rapid intracrustal remelting and chemical differentiation. It is likely that flare-up of insertial magmatic activity combined with rifting has led to periodic thermal weakening of the entire arc, resulting in fluctuating bulk rheology of arc lithosphere over time.

V41A-05 0900h

Crustal Architecture and Structural Patterns of the Cretaceous to Paleogene Cascades Arc

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The crystalline core of the North Cascades (Cascades core) preserves a crustal section of ca. 10- to 40 km paleodepths that facilitates evaluation of the crustal architecture and partitioning of strain during major shortening of this 96- to 45 Ma continental magmatic arc. The dominantly tonalitic plutons in the arc are steep-sided, vertically extensive bodies that commonly are sheeted. They intrude oceanic and arc terranes juxtaposed along initially gently dipping thrusts before 92 Ma. Shortening, crustal thickening, and amphibolite-facies metamorphism of the Cascades core were synchronous with large (> 100 km) thrust displacements at shallow levels in the ca. 100-80 Ma NW Cascades thrust system. Deformation in the core was dominated by early tight to isoclinal, gently inclined to recumbent folds that were followed by open to tight, more upright folds. SW-vergent, moderate to steeply dipping reverse shear zones, which postdate terrane juxtaposition, were localized next to plutons. They have < 10 km displacement and were responsible for less shortening than the folding. Metamorphic and geochronologic data indicate rapid burial of plutons and host rocks during the mid-Cretaceous deformation. Shortening in sub-greenschist-facies, ophiolitic rocks above the Cascades core was manifested by upright folds and steep reverse shear zones that reactivated Jurasssic faults inferred to have formed in an oceanic fracture zone. Folding and reverse shear persisted in the Cascades core until at least 65 Ma, well after major thrusting ceased in the NW Cascades system. The younger shortening structures are confined to deeper, more internal parts of the arc, and were probably localized in part by magmatism and thermal weakening. This shortening was also broadly coincident with cryptic thrust burial of sedimentary protoliths of the Swakane Gneiss from the surface to 40 km between 73 to 68 Ma. This underthrusting may have removed the roots of the arc plutons. Similar deformation patterns throughout the crustal section imply structural coupling of large parts of the arc. This coupling may reflect the consistently tonalitic composition (rather than more mafic composition with depth) of plutonic rocks and low paleogeothermal gradients of the section. Structural partitioning was more strongly controlled by relatively localized rheological contrasts, particularly the presence of rigid plutons and other mechanical anisotropy.

V41A-06 0915h

Tectonic evolution of the Notre Dame magmatic arc, Newfoundland Appalachians

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Notre Dame continental arc magmatism in Newfoundland had an overall lifespan of c. 60 Ma (489-429 Ma). Extensive age dating suggests that arc construction took place in 3 distinct stages, separated by gaps of magmatic quiescence (arc shut-off). The first phase of quiescence (c. 480-468 Ma) corresponds to the start of Taconic collision between the initially west-facing Notre Dame arc and Laurentia. The second phase of magmatic quiescence (455-445 Ma) corresponds to collision between the now east-facing Notre Dame arc and the west-facing, peri-Gondwanan Victoria arc built on a piece of Ganderian crust. Resurgence of arc magmatism followed stepping- back of the west-dipping subduction zone into the oceanic marginal basin that separated the Victoria arc from the Gander margin. A gradual transition (431-429 Ma) from arc-like to mainly juvenile, bimodal within plate-like magmatism coincides with suturing of the Notre Dame arc with the Gander margin along the Dog Bay line and probably reflects break off of the west-dipping Ganderian slab. Preservation of an unconformable and unmetamorphosed Silurian cover, consisting of red beds and bimodal volcanic rocks, over large tracts of the Notre Dame arc indicates that the arc was extinct and stabilized by the Late Silurian (c. 425 Ma) and did not experience any significant overprint during the Early Devonian Acadian orogeny, the effects of which were mainly localized further to the east due to accretion of Avalonia to Laurentia. The second, Mid-Ordovician phase of arc magmatism (c. 469-456 Ma) appears most voluminous and was mainly characterized by K-poor, calc-alkaline quartz diorite to tonalite and, to a lesser extent granodiorite, plutons. These calc-alkaline plutons intruded during deformation and significant thickening of the Notre Dame arc, presumably as a result of ongoing shortening following initial collision with Laurentia and an arc-polarity reversal. Such a tectonic scenario is consistent with the high metamorphic grade of the supracrustal rocks they intruded and high La/Yb content of most tonalites, which suggests melting of garnet-amphibolite near the base of an over thickened arc. The first evidence of emergence of the Notre Dame arc following its thickening is provided by unconformably overlying, late Caradoc (c. 453 Ma) subaerial ignimbrite and conglomerate. Parts of the Notre Dame arc show very rapid exhumation of its middle to lower crust at c. 430 Ma, following shortening during the Early Silurian. Exhumation was presumably triggered by slab breakoff during final suturing between Ganderia and Laurentia.

V41A-07 0930h

Crustal Structure and Rock Uplift due to Back-Arc Extension.

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We use crustal structure and exhumation data to estimate the density and partial melt variation in the mantle wedge of a back-arc extension system. A program of explosion seismology (NIGHT) in the central North Island (CNI) of New Zealand has unearthed an intriguing, isostatic contradiction: an association of profoundly thin continental crust with recent rock uplift. We explore properties of the upper mantle that might lead to sufficient buoyancy to compensate the

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0830 h **T41D-0257** *POSTER* Effect of Confining Pressure on Compaction Localization in Notched Samples of Bentheim Sandstone: Experimental Observations and Finite Element Modeling: **V Vajdova**, T Wong, V Challa, K A Issen

0830 h **T41D-0258** *POSTER* Anisotropic schist foliation orientation determined using time domain electromagnetics: **J L Collins**, M E Everett

0830 h **T41D-0259** *POSTER* Impact of tectonic stresses on compaction in the toe thrust region of a Tertiary Delta: **T G Fitts**, J Welton, J M DeGraff

0830 h **T41D-0260** *POSTER* Fundamentally Different Failure Mechanisms Around Boreholes in two High Porosity Sandstones: **B Haimson**, H Lee

0830 h **T41D-0261** *POSTER* Potential field Modeling of the 3-D Geologic Structure of the San Andreas Fault Observatory at Depth (SAFOD) at Parkfield, California: **D K McPhee**

0830 h **T41D-0262** *POSTER* "Intelligent design" of a 3D reflection survey for the SAFOD drill-hole site: **G Alvarez**, J A Hole, S L Klemperer, B Biondi, M Imhof

0830 h **T41D-0263** *POSTER* Comparison of SAFOD Pilot Hole phyllosilicate mineral assemblages to the Punchbowl fault: Recognizing post-faulting alteration in exhumed fault zones: **J G Solum**, B A van der Pluijm

0830 h **T41D-0264** *POSTER* Predicting Macroscale Physical Properties Using Microscale Image Data: **J T Fredrich**

T41E MCC: 2002-2004 Thursday 1020h

At the Seismogenic Front: Dynamic Processes at Convergent Margins II *(joint with G, S)*

Presiding: **S Bilek**, New Mexico Institute of Technology; **Y Liu**, Harvard University

1020 h **T41E-01** *INVITED* Friction Mechanics at the Updip Limit of Seismogenic Faulting Along Subduction Megathrusts.: **C Marone**, D M Saffer

1035 h **T41E-02** The Upper Aseismic to Seismic Transition: A Silica Mobility Threshold: **C D Rowe**, J Moore

1050 h **T41E-03** Seismic activity in the Japan Trench forearc from network observation in the seafloor: **E Araki**, S Sacks, A Linde, T Kanazawa, M Shinohara, H Fujimoto, R Hino, H Mikada, H Matsumoto, T Sato, K Suyehiro

1105 h **T41E-04** Seismicity along the Nankai trough seismogenic zone: results from micro-seismicity observations using ocean bottom seismographs: **K Obana**, S Kodaira, K Mochizuki, M Shinohara, K Suyehiro, Y Kaneda

1120 h **T41E-05** Geometry and velocity structure of the northern Costa Rica seismogenic zone from 3D local earthquake tomography: **H R DeShon**, S Y Schwartz, A V Newman, L M Dorman, M Protti, V Gonzalez

1135 h **T41E-06** Transient Fluid Pulsing and Noise in the Costa Rican Subduction Zone: Nearly Silent Slip Events?: **K M Brown**, H DeShon, M Tryon, L Dorman, S Schwartz

1150 h **T41E-07** Fluidization of Fault During Slip: A Possible Mechanism of low Dynamic Friction During the 1999 Chi-Chi, Taiwan Earthquake and Implication for Seismic Slip Along the Splay Fault in the Nankai Accretionary Prism: **K Ujiie**, A Kato, Y Kaneda, A C Trandafir, K Sassa

1205 h **T41E-08** *INVITED* Source Process of the 1999 Chi-Chi, Taiwan Earthquake: Comparisons to Shallow Faulting in Subduction Zones: **J Mori**

T41F MCC: 3007 Thursday 1020h

The Structure and Physical Properties of Grain Boundaries in Rocks II *(joint with V)*

Presiding: **T Hiraga**, Tohoku University; **S ten Grotenhuis**, HPT-Lab/Inst Earth Sciences

1020 h **T41F-01** *INVITED* Measurement of Grain Boundary Partitioning of Ar and He: **E F Baxter**, P D Asimow, K A Farley

1040 h **T41F-02** *INVITED* Equilibrium Grain Boundary Segregation in Mantle Rocks: Grain Boundaries as Reservoirs of Incompatible Elements: **T Hiraga**, I M Anderson, D L Kohlstedt

1100 h **T41F-03** The Composition of Olivine Grain Boundaries: J Fitz Gerald, **U Faul**, M Cmiral

1115 h **T41F-04** Electrical properties of polycrystalline olivine: evidence for grain boundary transport: **S M Ten Grotenhuis**, M R Drury, C J Peach, C J Spiers

1130 h **T41F-05** Does the electrical conductivity of partially molten rocks depend on grain-boundaries?: **F R Schilling**

1145 h **T41F-06** Hart's Mechanical Equation of State in Rock-Salt: Data and Theoretical Model Based on Subgrain Boundary Migration: **D S Stone**, T Plookphol, R F Cooper

1200 h **T41F-07** Grain Size Reduction and Deformation Mechanisms in Ultra-Fine-Grained Shear Zones From the Lherz Peridotite: G M Pennock, **M R Drury**, H G Ave Lallemant

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V41A MCC: 3006 Thursday 0800h

Birth, Growth, and Death of Magmatic Arcs: Comparisons Among Arcs in Different Settings III *(joint with T)*

Presiding: **N Petford**, Kingston University; **T Rushmer**, University of Vermont

0800 h **V41A-01** *INVITED* Expressions and controls on intra-crustal recycling: **G W Bergantz**, O Bachmann, J Dufek

0815 h **V41A-02** Possible Melts of Delaminating Lower arc Crust Beneath Arcs: **K Hanghoj**, P B Kelemen

0830 h **V41A-03** 4D constraints on melt source-rock input and granite production in continent-continent collision; a case study from a 50 km wide swath through the Himalayan magmatic arc: **M A Edwards**, G Wiesmayr, b Grasemann, m Meyer, h Hausler, b Miller, W Kidd, s Samson

0845 h **V41A-04** *INVITED* Rifting, Insertial Magmatism And Continental Arc Construction, Peru: **N Petford**, M Atherton

0900 h **V41A-05** Crustal Architecture and Structural Patterns of the Cretaceous to Paleogene Cascades Arc: **R B Miller**, S R Paterson, J P Matzel

0915 h **V41A-06** Tectonic evolution of the Notre Dame magmatic arc, Newfoundland Appalachians: **C van Staal**, J Whalen, S Pehrsson, V McNicoll

0930 h **V41A-07** Crustal Structure and Rock Uplift due to Back-Arc Extension.: **T Stern**, W Stratford, M Salmon, A Pulford

0945 h **V41A-08** Transient Dilatancy in the Transport of Magma and Flareup Magmatic Events: **S E Johnson**, P O Koons, P Upton

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V41B MCC: 3008 Thursday 0800h

Frontiers in High-Pressure Research: New Opportunities I *(joint with GP, MR, DI)*

Presiding: **A B Belonoshko**, Royal Institute of Technology; **Y Zhao**, Las Alamos National Laboratory

0800 h **V41B-01** *INVITED* Scientific Advancements and Technological Developments of

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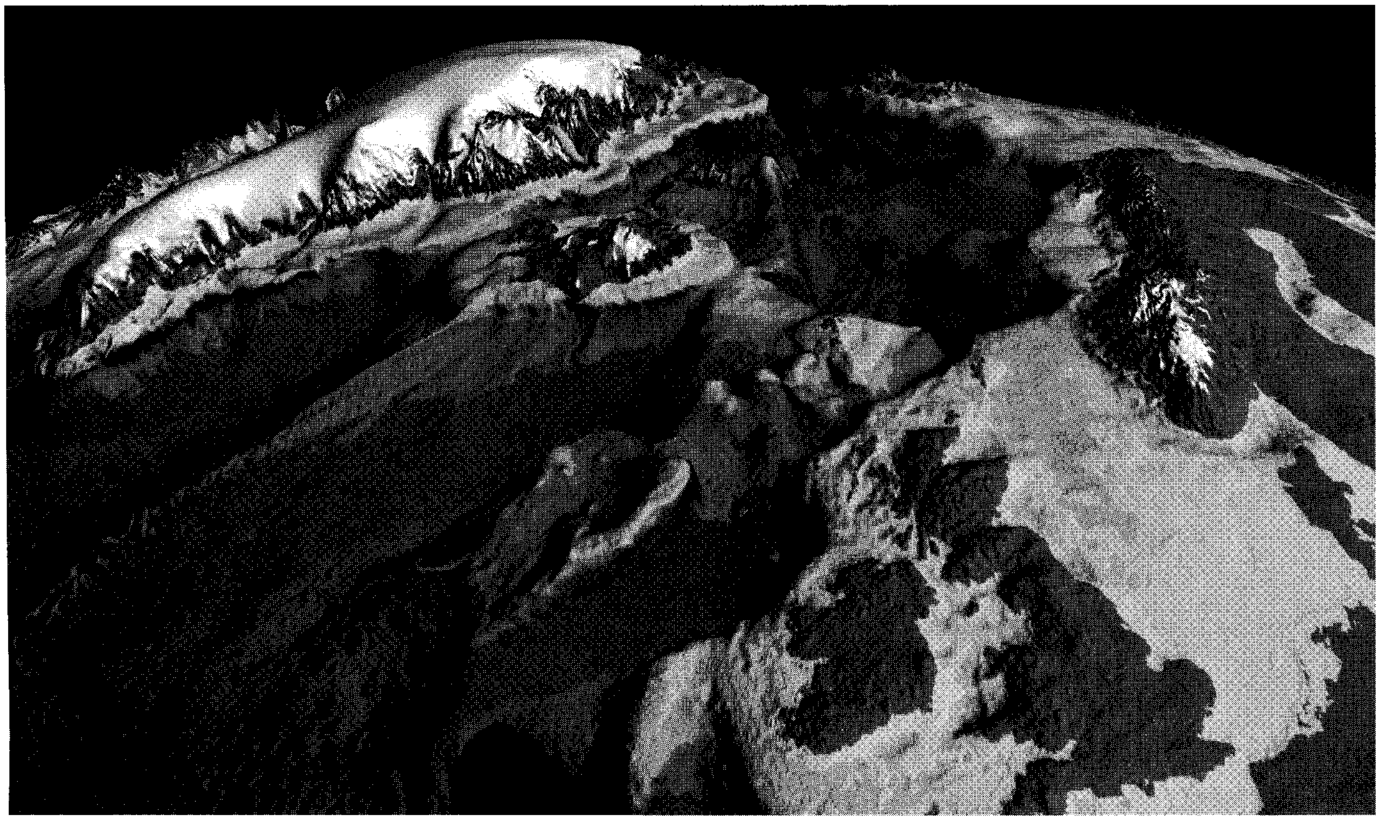
8-12 December 2003
San Francisco, California



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