It appears that a ridge is too buoyant to subduct by itself, and the ridge crest is unlikely to follow the same subduction path of the oceanic lithosphere preceding it during the subduction process. Most likely, ridge subduction is a passive process, such that the ridges are simply overridden by other plates. In this case, a subducting ridge will closely adhere to the bottom of the overriding plate. The simplest model to study the thermal consequences of such a process will be that of a conducting plate moving over a line source of heat. Since oceanic ridges suduct either with their axis parallel or perpendicular to trench axis, models of the two different subduction modes will also be discussed.

T 56

GEOMETRY OF SUBDUCTION - A THERMAL MODEL

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The path which subducting lithosphere follows can be broken into three zones: I) a sub-horizontal region of nearly constant dip near the trench; II) a region of rapidly varying curvature; and III) the region deeper than approximately 125 km., more steeply dipping but again of nearly constant dip. The relationships among age of lithosphere, velocity of convergence, and dip of the slab which have been proposed in the past, are not born out by observed subduction zone geometries. Time dependent thermal modeling of the subducting slab by the Method of Lines, a numerical technique well suited to the solution of time dependent P.D.E., allows the specification of the actual path followed by the slab and variations in age (initial temperature field) of the subducting lithosphere. Modeling results include: 1) the temperature fields in lithospheric slabs of different ages are essentially equivalent by the time the slab enters region III; 2) the curvature in region II is related to the thickness of the zone within the slab of temperature less than approximately 450°C.; 3) the final dip of the slab in region III seems to depend more on the nature of the overriding plate (whether oceanic or continental) than on velocities or age of lithosphere.

T 57

SUBDUCTION OF YOUNG OCEAN LITHOSPHERE AND THE NATURE OF LATE QUATERNARY VOLCANISM IN CENTRAL MEXICO

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(Sponsor: R.L. Chase)

Seismicity, volcano structure, and the composition of volcanic products in the Mexican arc are intimately related to the age and structure of young ocean lithosphere presently being consumed at the Middle America Trench. Lateral discontinuities in the distribution and density of intermediate-depth earthquakes are related to fossil transforms in the ocean floor and the age of the subducted slab. A slower rate of subduction of the Rivera plate beneath the western arc than that of the Cocos plate beneath the central and eastern arc is reflected by differences in Late Quaternary volcanic rocks of the Trans-Mexican Volcanic Belt. West of Colima, major volcanoes built of two-pyroxene andesite are smaller (<3000m above S.L.) and less voluminous (<70km^3) than hornblende andesite cones (4000-6000m in height; 200 km^3) to the east. A region of high-angle faulting and contemporaneous alkaline/calc-alkaline volcanism (the Colima Graben) overlies a sinistral transform fault that forms the Rivera-Cocos plate boundary in the downgoing slab.

T 58

RATES OF MOMENT-RELEASE AND CRUSTAL SHORTENING IN INTRAPLATE HONSHU, JAPAN, DETERMINED FROM QUATERNARY FAULT DATA

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Recorded offsets on active faults allow determination of the net moment released in intraplate Honshu, Japan during the Quaternary. For each active fault, the total moment ($\mu \ell w \Sigma \bar{u}$) is calculated. The contribution of all faults are then summed and Kostrov's [1974] formula is used to convert the resulting moment to permanent strain. In northeast Japan, where much of the seismicity lies off the Japan Sea coast, active Quaternary faults on land do not give a complete record of the seismic deformation. Rates of moment-release and crustal shortening for the Quaternary are significantly less in this area than those computed from more recent seismicity data. In southwest Japan, where seismicity is predominantly located onshore and large earthquakes are commonly associated with surface breakage, geologic fault displacements indicate the rate of moment-release has averaged about 1×10^{25} dyne-cm/yr during the Quaternary. Converting the moment-release to strain indicates that crustal shortening in an easterly direction has averaged about 0.3 cm/yr. This is about 3% of the rate of plate motion being accommodated along the Japan Trench. These results are in good agreement with deformation rates determined using 400 years of historical seismicity data, indicating that the rate of deformation in intraplate Japan has been relatively constant throughout the Quaternary.

T 59

SUBDUCTION OF THE CARIBBEAN PLATE AND NEOGENE UPLIFTS IN THE OVERRIDING SOUTH AMERICAN PLATE

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The Venezuelan Andes and Sierra de Perija, and the Colombian Santa Marta Massif are rigid basement blocks uplifted 7 to 12 km in the last 10 my. Their tectonic style is similar to that of Laramide orogenic structures in the Colorado-Wyoming Rocky Mountains. New gravity observations and published data in Colombia and Venezuela have been used to model a cross-section. Crystalline basement of the Venezuelan Andes has been thrust to the northwest over Tertiary sediments on a fault dipping about 25° and extending to the mantle. In the Sierra de Perija Mesozoic sediments have been thrust 15 km to the northwest over Tertiary sandstones along the Cerrejon fault. A fault dipping 15° to the southeast is consistent with field mapping, gravity, and density data. The Santa Marta Massif has been uplifted 12 km in the last 10 my by northwest thrusting over sediments. Total crustal shortening for the three mountain ranges is over 100 km.

Earthquake hypocenters define a subduction zone dipping 25 to 30° to the southeast. Active subduction of Caribbean crust beneath South America is indicated by deformed Plio-cene-Pleistocene turbidites in the Colombian Trench. There has been no magnetic activity associated with the late Cenozoic subduction. The basement block uplifts along low angle thrust faults reveal horizontal compression in the overriding plate at distances of over 500 km from the convergent margin.

T 60

THE TECTONICS OF NW SOUTH AMERICA FROM SEISMICITY AND FOCAL MECHANISMS

Wayne Pennington (Dept. Geological Sciences, Univ. of Texas, Austin, TX 78712)

Hypocentral locations of earthquakes selected from the Bulletins of the International Seismological Centre to consider only well-located events and determination of focal-mechanisms from the seismograms of the World-Wide Network have led to the definition of major active tectonic boundaries in northwestern South America and neighboring areas. Interaction of relict plate boundaries, active boundaries, and bathymetric and continental features appears to be the cause of the current complex geometry.

There is no single triple junction separating the Caribbean, South American, and Nazca plates. Instead, the Panamanian isthmus and surrounding areas are accommodating east-west compression and a lesser degree of north-south compression along a series of thrust faults striking NW to NE. This diffuse boundary results in an apparently-convergent margin north of Panama, whereas the simpler Cocos-Caribbean boundary (which lies entirely at the axis of the trench) results in an apparently-passive margin north of Costa Rica.

The Andean ranges of Ecuador, Colombia, and Venezuela are moving as a block NNE relative to the rest of the South American plate, along a system of faults following the front of the Eastern Cordillera. This system has not been recently seismically active from southern Colombia to the Gulf of Guayaquil. If the boundary does indeed exist in this region, it should be considered an area of high seismic risk. Local seismic monitoring will be necessary to determine the specific fault geometry and risk.

T 61

THE ALPINE FAULT OF NEW ZEALAND AND ITS RELATIONSHIP TO THE PACIFIC-INDIAN PLATE CONVERGENCE

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Analysis of the Bouguer Anomaly map of South Island, New Zealand, indicates that the dip of the Alpine fault may vary in such a way that movement on the Fault is a transition between two oppositely dipping subduction zones. The model suggests that north of the Mt. Cook region, Pacific continental crust is being deflected upwards at the Fault and is being eroded. Further south, Pacific crust is being thrust over the Lord Howe Rise on a shallow dipping thrust plane. The model is able to explain many previously unrelated observations about crustal structure, hot springs, and the Fiordland subduction zone.

T 62

THE PLIO-PLIESTOCENE DEFORMATION OF THE CENTRAL RANGE, SOUTHERN TAIWAN

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(Sponsor: Juhn G. Liou, Stanford Univ.)

Taiwan is situated at the site of flipping subduction polarity between the Manilla/Luzon and Ryukyu arc systems. Along the Manilla trench, ocean floor rocks of the South China Sea and slope-rise sediments seaward of Asia have been accreted to form Taiwan's Central Mountains. The low-grade metamorphic core of this range (Tananao Schist) with its Eocene flysch cover (Hsinkao Fm.) represents part of the accretionary prism which has emerged during Plio-Pliestocene collision of the Luzon Arc with Asia.

During a 60 km. traverse of a southern part of the range, the structural/metamorphic history was compared between the Tananao Schist and the unconformably overlying Hsinkao Fm.. Structural and lithic analyses revealed a furthur unconformity at the top of the Tananao (below the newly delineated Chu-lai Formation) as well as supported the paleontologically dated Eocene unconformity mentioned above. They both show sharp, unsheared contacts which are systematically truncated on a regional scale.

Six generations of folds are present throughout the Tananao and Chu-lai (F_1-F_6), while only five are present in the Hsinkao. Assuming an Eocene age for the Hsinkao, most of the observed deformation in the southern Central Range is Plio-Pliestocene and not older (Mesozoic)as suggested by others in this region. Older structural fabrics are largely destroyed by this younger deformation and metamorphic grade is uniformly low-grade greenschist throughout.

T 63

NEOTECTONICS OF EASTERN ANATOLIA

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Late Miocene collision resulted in the N-S compression of eastern Anatolia between Arabia and the Caucasus and the westward escape, towards the Mediterranean free face, of the Turkish wedge, bounded by the dextral North Anatolian Transform and the sinistral East Anatolian Transform. Both transforms show mega-sag ponds, truncated spurs, deformed gravel fans and differential relief of up to 1000 m. Transform imperfections yield oblique thrust segments and pull-apart lignite basins. The N-S compression from Late Miocene has generated N-S volcanic fissuring and E-W folding and thrusting of basalts and sedimentary ramp basins, the tilting of whose margins has caused antecedence and terrace splitting. Conjugate faulting shows a change in dihedral angle of 90° in the east to 120° in the west suggesting an westward increasing horizontal plane strain. Two major triple junctions, Karliova and Adana, have associated major sedimentary basins resulting from complex separations between blocks deforming by differing amounts.

T 64

ON THE GRAVITY ANOMALIES AND DYNAMICS OF THE HIMALAYA

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Recent studies of the gravity field of the Himalayan and the Tibetan regions (Zhou, et al., 1980) have shown that the Himalaya is characterized by a broad band of positive isostatic anomalies parallel to the main ridges. The anomalies are large, reaching 120 mgal in the vicinity of the Qomolangma Peak (Mt. Everest). Geodetic releveling (Chugh, 1974) further shows that the Himalaya is presently uplifting at a rate of about 4 to 5 mm/yr with respect to the Ganges Basin. These two kinds of evidence show that the present elevation of the Himalaya must be dynamically supported. We use finite element modeling, constrained by the observations and by choices of reasonable crustal models and rheology, to investigate the nature of the tectonic forces which are responsible for the observed gravity anomalies and uplift rates. Two basic models have been used in our modeling: In one, both the crust and the upper mantle are treated as rheological materials and the uplift of the Himalaya is a result of NS compression. In the other, a continent-continet collision is assumed and the uplift is affected by the underthrusting of the Indian plate beneath the Himalaya.

T 65

THERMAL EFFECTS OF CRUSTAL THICKENING

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M.N. Toksöz

Plateaus adjacent to continental convergence zones such as in the Alpine-Himalayan belt are areas of anomalously thick crust. It is likely that internal deformation of the crust is in part responsible for the thickening. Low seismic velocities and high attenuation indicate high temperatures and possible partial melting in the lower crust. Calc-alkaline volcanism in areas such as Tibet is considered to be due to crustal melting.

A mechanism for crustal thickening is internal deformation and vertical translation of material. In this study we calculate the thermal consequence of such thickening using a finite difference method. The grid spacing is increased at every time step during the calculation according to the amount of and total time for the thickening. The heat production in the crust is taken to be due to a given distribution of radioactive sources as well as strain heating from the deformation. Shear stresses are taken to be between 1 and 2 kilobars. The boundary conditions were fixed temperature for the surface and either fixed temperature or fixed heat flux at depth in the mantle.

We have considered the case of a doubling in crustal thickness in forty million years. This is taken to represent a mechanism to produce the 70 km thick crust in Tibet since the collision of India with Asia. Strain heating is found to be insignificant, while the redistribution of radioactive sources and increase in mantle temperature are important factors in determining whether the lower crust can partially melt. Homogenization of radioactive source can lead to this melting even with normal mantle temperatures and higher than normal mantle temperatures lead to significant melting. After 40 m.y., mid and upper crustal temperatures are no higher than for normal crust unless there is transport of heat via movement of magma.

T 66

ANGULAR UNCONFORMITY AND THRUST FAULT IN THE UMTANUM ANTICLINAL UPLIFT NEAR PRIEST RAPIDS DAM, CENTRAL WASHINGTON

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The Umtanum thrust fault zone and an angular unconformity are exposed on the north flank of the Umtanum anticline in the Filey Road area. The unconformity is between the deformed Grande Ronde and Wanapum Basalt, and the overlying Saddle Mountains Basalt and interlayered Ellensburg Formation. The fault zone consists of three imbricated slices of deformed and overturned Grande Ronde and Wanapum Basalt. The lower fault plane dips 26° south. A deformational origin for the imbricate thrust zone is documented by the continuity of overturned (dip less than 30°) Wanapum Basalt subunits and the penetrative nature of the fractures. Near the eastern margin of the area a left-lateral tear fault displaces the Umtanum anticline northward nearly 1 km. Total north-south horizontal shortening is greater than 2.5 km. Side-stream Ellensburg conglomerate of pre-Pomona (probably pre-Umatilla?) age unconformably caps the deformed units. Two phases of deformation are recognized. The early (D_1) phase is the main period of deformation when most, if not all, of the thrusting and folding occurred. D_1 deformation began in post-Wanapum (Priest Rapids) time and ended before Umatilla(?) time. A second (D_2) phase of deformation resulted in minor folding and uplift of Umtanum Ridge. No evidence of Quaternary deformation is present. The (pre-Umatilla? age) angular unconformity and thrust fault zone document a regional deformation (D_1) involving most of the northwestern Columbia Plateau north of Yakima Ridge in the CLEW. The geometry of the Umtanum thrust fault zone is consistent with a model of north-south (σ_1 horizontal) compression with decollement on several sedimentary interbeds within the Grande Ronde and Wanapum Basalt.

Temperature and Convection in the Earth's Mantle

Crystal HI
Tuesday PM
Douglas W. Oldenburg (U of British Columbia), Presiding

T 67

THE GEOCHEMICAL EVOLUTION OF THE MANTLE

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Trace element and isotopic data imply the presence of ancient depleted and enriched mantle reservoirs. Nevertheless, recent models assume that continental crust is the only enriched reservoir and that ~70% of the mantle is primitive. The source region for alkali basalts is ancient and enriched (Pb-isotopic studies) or primitive (some Nd-isotope investigators). The enrichment is too great to accommodate present isotopic ratios. The MORB source is enriched (Pb) or depleted (trace element and Nd-Sr studies). By utilizing evidence that a) enrichment has been progressive and b) depleted magmas are more sensitive to Pb than to Sr-Nd contamination, a model can be obtained which satisfies all three isotopic systems and a variety of other data. Early differentiation followed by crystal fractionation is one interpretation of the data. A garnet-rich cumulate layer, the source of ancient enriching fluids, is the present MORB reservoir. The overlying peridotite layer (LVZ) has become progressively enriched and is the source region for OIB and alkali basalts. Less than 1% contamination of MORB by LVZ material makes MORB appear enriched (future ages) on Pb-Pb diagrams while Nd and Sr remain depleted. This is a consequence of mixing relations and the Pb-enrichment of the uppermost mantle. There is no need for a primitive reservoir or continuous extraction of Pb from the upper mantle to the core. Partition coefficients are such that Rb/Sr and Sm/Nd ratios are nearly unfractionated in the primary melt and its cumulates. Extraction of residual melt from the garnet cumulate layer and injection into the LVZ is responsible for enrichment/depletion events. The increase of Rb/Sr, Nd/Sm and U/Pb with time in the LVZ collapses the spread of ε and makes enriched reservoirs of all ages appear almost primitive.

T 68

TEMPERATURES IN THE DEEP EARTH

Guy Masters (Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, University of California, San Diego, La Jolla CA 92093)

The temperature (T), Grüneisens ratio (γ) and other thermodynamic properties of a material undergoing adiabatic compression can be described by simple series expansions of the form: $T = T_0 + T_1x + T_2x^2 + \ldots$ where $x = (\rho-\rho_0)\rho$ and ρ is density. The series converge very quickly at the compressions found in the Earth if γ is a smooth function of compression. Comparison with series derived from finite strain theory show that the simple series perform better and, in particular, do not predict negative values for the thermal expansion at finite compressions.

High temperature, zero pressure, thermodynamic data for minerals and liquid iron have been used to derive adiabatic temperature distributions for the lower mantle and core. Despite the considerable uncertainties in the zero pressure values, the results strongly suggest the presence of a thermal boundary layer between mantle and core. This result is in accord with several recent studies and gives an adequate explanation of the seismic properties of the base of the mantle.

T 69

SUPER-ADIABATIC GEOTHERM AND CONVECTION IN THE LOWER MANTLE

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J. M. Brown (Dept. of Geophysics, Texas A&M University, College Station, TX 77843)

We have used several seismic profiles of compressional and shear velocity, V_p and V_s, and density ρ to calculate non-adiabatic density changes in the earth. Over an interval of depth this change is the fractional difference between $\Delta\rho/\rho$ from the profile and $\Delta P/K_S$ where pressure P and adiabatic bulk modulus K_S are also calculated from the profile. As is well known, the lower mantle closely, but not quite, matches the Adams-Williamson condition where the fractional difference is zero for homogeneous self compression. By attributing the fractional difference to thermal expansion ($-\alpha\Delta T_{na}$) where α is the volume coefficient of thermal expansion we can calculate T_{na}, the non-adiabatic temperature contribution. For the smoothest profile, PEM, T_{na} has the S-like shape predicted for super-adiabatic, laterally averaged temperature in a convecting medium. For models 1066B and C2 the S-shape is more exaggerated. While tentative, these temperature profiles are consistent with a separately convecting lower mantle relatively isolated from the upper mantle.

T 70

CONDUCTIVITY STRUCTURE OF OCEANIC UPPER MANTLE BENEATH THE PACIFIC PLATE

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Ocean bottom magnetotelluric responses from three ages on the Pacific plate have been inverted to reveal the presence of a conductive zone whose depth is a function of lithospheric age. The conductivity achieves its maximum value (~.1 S/m) at depths near 70, 120, and 180 km for lithospheric ages of 1, 30, and 72 my respectively.
An explanation in terms of partial melt-

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T 49

INTERACTION OF A HOT SPOT AND A MID-OCEAN RIDGE - THE JUAN De FUCA RIDGE CREST

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A thirty day survey of the axial zone of the Juan de Fuca Ridge segment extending from the Blanco F.Z. to the Cobb F.Z. included 21 magnetometer/airgun profiles perpendicular to the ridge, 54 dredge stations along the ridge axis, eight deep-tow camera runs, and five hydrocasts. The southern and northern portions of this ridge segment exhibit considerable bathymetric and magnetic symmetry such that the center line of the Brunhes-Matuyama boundaries yields fresh volcanic glass upon dredging. In contrast, the middle third of this segment, adjacent to the Brown Bear Seamount, exhibits pronounced Bathymetric asymmetry and yields fresh glass only along a zone which is displaced to the west of the projected axial zones. The dominant rock types recovered were sparsely phyric, vesicle-poor pillow and sheet flows. Dredging and photographic studies indicate that the ridge axis is capped with approximately equal amounts of pillow basalt and sheet flows.

Near the northern end of the ridge segment at 47°30'N, described as a 'propagating rift' (Hey, 1977), the active ridge curves slightly to the west and disappears beneath sediment cover. Reflection profiling in this vicinity indicated graben-like extension structures in the sediments along the northward projection of this curved ridge. Ten to fifteen kilometers south of the zone of deformed sediments, dredging recovered pillow basalts with thick, extremely fresh glass and crusts of 2-4 inch thick iron-rich deposits of hydrothermal montmorillonite.

T 50

A NEW CHRONOLOGY FOR THE COMORO ISLANDS, WESTERN INDIAN OCEAN, AND IMPLICATIONS FOR SOMALI PLATE TECTONICS

Christina Emerick (School of Oceanography, Oregon State University, Corvallis, OR 97331)
Robert Duncan

The Comores Islands and the Tertiary volcanic province of Northern Madagascar form a sub-linear trend of alkalic shield volcanoes across the northern entrance of the Mozambique Channel. Potassium-argon dating of shield building lavas confirms an eastward increase in age of volcanism along the chain, which is consistent with a hotspot origin for the lineament. The rate of migration of the Somali Plate over the mantle magma source is approximately 45 mm/yr.

The new geochronology for the Comores chain is used in conjunction with existing data for the Reunion-Mascarene Plateau hotspot to model the absolute motion of the Somali Plate for the last 10 m.y. A systematic departure of Somali Plate absolute motion from African Plate absolute motion during this time period represents a component of relative motion across the East African Rift. By subtracting our best-fit Somali Plate motion from the African absolute motion we obtain an independent estimate of the timing and magnitude of separation across the Rift.

The geometry of older portions of the Comores and Reunion trends indicates that there was no significant relative motion between the African and Somali Plates prior to about 10 m.y. ago.

T 51

CENTRAL BASIN FAULT REVISITED

C.S. Lee (Dept. of Oceanography, Texas A & M Univ., College Station, TX 77843)
T.W.C. Hilde (Depts. of Oceanography & Geophysics, Texas A & M Univ., College Station, TX 77843)

Recent magnetic anomaly studies of the West Philippine Basin have shown that the Central Basin Fault is a former spreading center, variously suggested to have become extinct at -42 m.y., -40 m.y. and -26 m.y., having had either one or two spreading periods in either constant or different direction. These and additional studies also suggested that the actual strike of the Central Basin Fault is nearer to E-W than the N55°W strike shown on existing bathymetric charts. In 1973 R/V CHIU LIEN of the Institute of Oceanography, National Taiwan University made eight long crossings of the Central Basin Fault along which bathymetric, magnetic, seismic reflection and heat flow data were collected. Basalt was dredged from the Central Basin Fault rift on one crossing. These data have been combined with existing data compilations to examine the structure, age and tectonic history of the Central Basin Fault and adjacent seafloor. The Central Basin Fault is found to strike ~N75°W, and from east to west to be progressively offset to the north by numerous fracture zones. Correlation of magnetic anomalies and reversal model studies support a -26 m.y. age for cessation of spreading on the eastern part of the Central Basin Fault, but complicate the development of an evolutionary history for this region. Never-the-less, a greater than 2.0 HFU mean heat flow in this area supports the younger age. The basalt dredged from the Central Basin Fault, dated at -10 m.y. may represent even later stage activity. The age and distribution of lineations along the western extension of the Central Basin Fault constitute a complex pattern which may require multiple spreading centers or ridge jumps.

T 52

ON THE CO-EXISTENCE OF JURASSIC MAGNETIC ANOMALIES AND A CRETACEOUS VOLCANIC COMPLEX IN THE NAURU BASIN, WESTERN PACIFIC OCEAN

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S.O. Schlanger (Hawaii Institute of Geophysics, University of Hawaii, Honolulu, HI 96822)

Jurassic oceanic crust characterized by easily recognized magnetic anomalies is overlain in the Nauru Basin by more than 500m of Cretaceous basalts and volcaniclastic sediments that are at least 30 m.y. younger than the underlying basement. This paradox raises magnetic, structural and thermal problems associated with the existence and emplacement of the Cretaceous volcanic complex. The magnetic problem is explained by the uniformly normal magnetization of the Cretaceous basalts that makes them invisible to a surface-towed magnetometer. The most likely solution to the structural question is a system of tension cracks and fractures with negligible vertical offsets that did not disrupt the Jurassic magnetic structure, but provided pathways for the Cretaceous magma. The thermal problem appears critical because oceanic basalt can be demagnetized at low temperatures (100-150°C) if applied for long enough periods of time (10-100 yrs). Thus, conductive cooling alone of these Cretaceous dikes will thermally demagnetize much of the adjacent Jurassic basement. It is possible, but unlikely, that the Cretaceous volcanic complex had only a few source vents. However, we suspect that the Nauru Basin was prevaded with stress cracks and dikes, and that convective cooling by seawater admitted through these tension fractures is also required to maintain the Jurassic basement below its magnetic blocking temperature for extended periods of time.

T 53

THE DISTRIBUTION OF INTRAPLATE VOLCANISM IN THE PACIFIC OCEAN: A SPECTRAL APPROACH

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A. B. Watts (Lamont-Doherty Geological Observatory of Columbia University, Palisades, N.Y. 10964)

Spectral analysis of marine gravity and bathymetry data have been used to estimate the distribution of volcanism on the Pacific plate in space and time. Estimates of the gravitational admittance and the average power spectrum of the bathymetry were obtained as functions of the age of the lithosphere by dividing the Pacific plate into eight age regions A-H. The power spectrum of the bathymetry $P_B(k)$ provides a measure of the overall topographic roughness (primarily volcanic) of the plate; an estimate of the proportion f_I of intraplate volcanism emplaced on relatively thick lithosphere (effective elastic thickness T_e = 25 km) relative to that generated at or near a ridge crest (T_e = 5 km) is provided by the admittance representing a best fit to the gravity and bathymetry data. The power spectrum and the admittance together allow an estimate of the total bathymetric power $P_I=f_IP_B$ accounted for by intraplate volcanism ("intraplate power") as a function of age. The overall topographic roughness of the plate, exclusive of well-known linear island chains, has three gradations: regions A-D (age <80 MY) have few volcanic features and are relatively smooth; regions E(80-100 MY) and G(120-140 MY) are of intermediate roughness; and regions F(100-120MY) and H(>140 MY), with large seamounts are very rough. Region H shows the highest proportion $f_I \sim .90$ of intraplate power, followed by F, with G and E having somewhat lower values $f_I \sim .40-.60$. Region H far exceeds all others in intraplate power P_I, followed by F, G and E in order of decreasing P_I. Estimates of the admittance are affected by two-dimensionality in the bathymetry although we estimate errors from this source do not exceed 10%. We examine these results in terms of the models for geological evolution of the Pacific ocean basin and the origin of intraplate volcanism.

Subduction and Continental Compression Zones
Crystal HI
Tuesday AM
Wayne Pennington (U of Texas), Presiding

T 54

BENDING STRESSES IN SUBDUCTED LITHOSPHERE

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Geoffrey F. Davies (Dept. Earth and Planetary Sciences, Washington University, St. Louis, MO 63130)

The effect of the strength of subducted lithosphere on the shape of the flow in the mantle is uncertain. The bending of the lithosphere at subduction and straightening within 150 km show that locally the strength of the lithosphere is exceeded by the forces that drive the plates. At greater depths, normal forces arise from the negative buoyancy of the slab and from dynamic flow stresses in the surrounding mantle. We present estimates of these forces and of the slab's response to them.

The flow of the mantle near the lithosphere is taken to be corner flow dominated by a no slip condition at the surface and along the subducted slab. We treat the subducted lithosphere as an elastic plate with flexural rigidity and thickness based on deflection of surface oceanic lithosphere under loads, which is an upper limit for warming subducted lithosphere. The calculated normal component of negative buoyancy of the slab includes estimated effects of phase changes on density.

Bending stresses resulting from the net normal load distribution vary along the slab, but are greater than 20 kbar along much of its length (down dip). This lower bound exceeds the largest yield stresses estimated from studies of the deflection of surface lithosphere (5 - 10 kbar). We conclude that the strength of the subducted lithosphere is small compared to the forces applied to it, and that it will therefore tend to follow the flow shape of the surrounding mantle.

T 55

SOME REMARKS ON RIDGE SUBDUCTION

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Subduction of old oceanic lithosphere is relatively easy to understand. It can be attributed to the cooling of the lithosphere such that it becomes gravitationally unstable to remain on top of the hotter and more buoyant mantle material. However, the mechanics of ridge subduction or the subduction of very young oceanic lithosphere are not immediately apparent. It can be demonstrated that oceanic lithospheres thinner than about 50 km will be stable against gravity if typical crustal density and crustal thickness are assumed. In order to calculate the thermal consequences of ridge subduction, it is necessary to understand how ridges subduct.

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AGU FALL MEETING
Head for the Hills
San Francisco·Dec. 8-12

Section Luncheons

Geodesy	Tuesday, December 9 Casa de Cristal 1122 Post Street	12 noon
Hydrology	Wednesday, December 10 Casa de Cristal	11:50
Oceanography	Tuesday, December 9 Nikko Sukiyaki Van Ness and Pine	12:15
Seismology	Tuesday, December 9 '1906 Drinking Establishment' Holiday Inn Golden Gateway	11:30
Solar-Planetary Relationships	Wednesday, December 10 Nikko Sukiyaki	11:45

Space is limited—reserve early! All luncheons—$7.50.

See page 928.

Cover. The aurora, displayed in multiple bands and photographed near Fairbanks, Alaska, by Malcolm Lockwood. This is a reproduction of a color plate from *Majestic Lights—The Aurora in Science, History and the Arts,* by Robert H. Eather. This book is AGU's most recent release.