T52D MC: 308 Friday 1330h

Ophiolites and Continental Margins of the Pacific Rim and the Caribbean Region II *(joint with GP, OS, V)*

Presiding: **Y Dilek,** Miami University; **M F Flower,** University of Illinois at Chicago

T52D-01 1335h INVITED

Ophiolites as Indicators of Rapid Global Tectonic Change

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Geochemically, few ophiolites have simple compositions that enable them to be assigned easily and unambiguously to a single tectonic setting. More common are complex geochemical variations in space and time that indicate a rapidly evolving tectonomagmatic environment. Some of the world's best-exposed ophiolites provide some of the best examples, notably Semail (Oman), Bay of Islands (Newfoundland), Zambales (Philippines) and Pindos (Greece). The trend from MOR (mid-ocean ridge) to SSZ (supra-subduction zone) geochemical signatures is particularly significant. It can be seen in many mantle sequences where mineral and bulk-rock geochemistry (e.g. oxygen fugacity v Cr-number of chromites) indicate a polyphase origin, commonly as a MOR melting residue that has interacted with SSZ magma. Overlying plutonic sequences are represented by the products of MOR-type magma chambers intruded, or underplated, by the products of SSZ magmas (e.g. wehrlites). Lava stratigraphies similarly range from MORB-like compositions at the bases to SSZ-like (e.g. high Th/Nb ratio) compositions in their upper units, significantly with no major eruptive hiatus between the two. Ophiolites of this type are commonly components of ophiolite belts, many of which are broadly comtemporaneous with major plate reorganisations in the geologic record. These reorganisations, in turn, can usually be linked to major ocean opening or continent collision (end-subduction) events. Around the Pacific Rim, the most recent example is the present (e.g. Zambales ophiolite) and future (e.g. Mariana forearc) mid-Eocene ophiolite belt, which may be due to the India-Tibet collision triggering a subduction-initiation event in the Western Pacific. Cretaceous and Jurassic plate re-orientations linked to plume activity and stages of Atlantic opening, and a more enigmatic Ordovian re-orientation, produce major ophiolite belts around the world that include parts of the Pacific rim. In terms of process, ophiolites of this subduction-initiation type provide significant information on the mantle dynamics and process of oceanic crustal accretion during the rapid change from extensional to compressional tectonics. Other types of linked ophiolite generation and rapid tectonic change include ophiolites formed during ocean opening and ophiolites related to migration of ridge-trench intersections, both of which also have many examples around the Pacific rim.

T52D-02 1350h

THE ORIGIN AND TECTONIC SIGNIFICANCE OF OPHIOLITES

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As defined by the 1972 Penrose Conference, ophiolites consist of a distinctive assemblage of mafic to ultramafic rocks, which, in complete bodies, includes mantle peridotites, gabbros, plagiogranites, sheeted dikes, mafic volcanic rocks and minor sedimentary rocks. Sheeted dyke complexes are taken as evidence of extension in a seafloor-spreading environment. Complete sequences are very rare and most ophiolites consist primarily of peridotite, gabbro and basalt, typically with tectonic contacts. Well-developed sheeted dyke complexes are rare suggesting either a lack of formation or tectonic removal during emplacement. We suggest that those ophiolites with poorly developed dyke complexes formed in an environment dominated by amagmatic extension.

For many years ophiolites were thought to have formed at mid-ocean spreading ridges, a misconception fueled by the assumption of large-scale spreading and an abundance of MORB-like lavas. However, most ophiolite lavas have a suprasubduction zone signature, at least in part. The lavas range from MORB to arc tholeiite to boninite and many complexes contain two or more lava types. In some cases, the lavas are highly evolved and include andesites and rhyodacites, as well as basalts. We believe that the different lava types primarily reflect formation in different parts of a suprasubduction zone environment, however, pieces of old ocean lithosphere may also be incorporated in some ophiolites.

We define ophiolites as fragments of suprasubduction zone lithosphere formed during subduction rollback that have been emplaced onto continental margins. Some ophiolites may also contain fragments of mid-ocean ridge lithosphere. Although ophiolites are distributed along continental margins, their emplacement does not necessarily reflect final closure of the ocean basin in which they formed.. Thus, several ophiolite belts may occur within a broad suture zone between continental blocks. Thus, ophiolites in the geologic record provide evidence primarily of subduction zone tectonics, not mid-ocean ridge spreading. Although they typically lie between continental blocks, their emplacement may predate final closure of the ocean basin in which they formed by many millions of years.

T52D-03 1405h

How Plate Kinematics Creates and Sweeps Away Supra-subduction ophiolites

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A major characteristic of Circum Pacific belts is their integration of ophiolitic bodies of various size. A common point of these ophiolite is their origin as supra subduction ophiolites. They are therefore originated from convergent margins. In SE Asia, most of the ophiolitic bodies accreted during the Tertiary are remnant of arc-back arc systems that have developped along the edge of the Sunda and Australian craton, or have developped together with the Philippine Sea Plate. Because of fast relative plate velocities, the geodynamic setting of the active margins of these three plates has also changed rapidly, modifying the parameters for the convergence. Because the obliquity of the convergence always generate strain partitionning, new paired trench and strike-slip systems are created, moving blocks further away from the locus of accretion. Accurate GIS-based reconstructions (by rotation of all the elements integrated in the database), indicate that the relative location of the plates and distances between them is determinant, so that at a given time, location of units can be confronted to the tectonic and petro-geochemical data. For example, in NW New Guinea, recent studies have shown the presence of two back-arc basins of different ages ; one opening between the Middle Jurassic and Early Cretaceous and responsible for the New Guinea Ophiolite obducted between 40 and 30 My, and the other opening during the Oligocene to Middle Miocene and obducted in the early Pliocene. These data suggest that an extensive portion of oceanic crust extended the Australian Plate a considerable distance north of the Australian craton. As Australia began is northward drift in the early Eocene, that crust was subducted. Thus the portion of the Philippine Sea Plate carrying the Taiwan-Philippine Arc and its partly ophiolitic basement to its present site may have actually been in contact with the ophiolite of New Guinea and created obduction. Other ophiolites with controversal origin are those present in Luzon (Northern Philippines). New field data in Northern Luzon and geophysical surveys including dredging in the Huatung basins allow us to consider a mid to Late Cretaceous age for the ophiolite of the Central Cordillera, and a similar origin in front of Australia, on the edge of the embryonic Philippine Sea Plate.

T52D-04 1420h

The Significance of Paired Ophiolite Belts - Examples From the Western Pacific and Caribbean

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Both the Zambales Ophiolite Complex (ZOC), Philippines, and the Mayari-Baracoa Ophiolite Belt (MBOB), Cuba, comprise two geochemically distinct ophiolitic assemblages. In the ZOC, the Coto Block contains a mantle sequence characterised by depleted residual harzburgites with a thin dunitic transition zone. Chromitites are of the high-Al variety (Cr2O3=30-44 wt%; Al2O3=20-30 wt%). The adjacent Acoje Block has a less depleted lherzolite-harzburgite mantle sequence, a well developed dunitic transition zone and high-Cr type chromitites (Cr2O3=45-53 wt%; Al2O3=12-18 wt%). The MBOB is made up of two massifs, the Moa-Baracoa Massif (MBM) and the Mayari-Cristal Massif (MCM). The MBM consists of depleted harzburgites with abundant high-Al podiform chromitites, whereas the MCM comprises peridotites with high-Cr podiform chromitites. The occurrence of two adjacent mantle sequences in each of these ophiolites makes them excellent examples of "paired ophiolite belts".

The distinct mantle sequences have different REE and PGE patterns that demonstrate that they have different origins in terms of their source regions, partial melting and melt-rock interaction processes. High-Cr chromitites crystallised from refractory (boninitic) melts whereas high-Al chromitites were associated with tholeiitic melts. These differences can best be accommodated in a model in which the more depleted sections are formed as part of a volcanic arc sequence, whereas the less depleted sections formed in a back arc basin. As such, paired ophiolite belts may provide evidence of subduction polarity and the nature of mantle dynamics in a suprasubduction zone environment.

T52D-05 1435h INVITED

Magmatism Within the SW Pacific Modern Analogs of SSZ Ophiolites, With Implications for the Tectonic Setting of Ophiolite Formation

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Petrological and geochemical studies of primitive Lower and Upper Pillow Lavas of the Troodos Ophiolite, a classical well-preserved example of SSZ ophiolites, have demonstrated(1) that these two main magmatic units are unlike boninite-arc tholeiite associations found along forearcs(2) and main volcanic fronts of modern island arcs. The LPL are likely originated from a source similar to those of Back Arc Basin Basalts, whereas UPL were formed from a deeper, hotter and more refractory mantle source.

The 1994 ProFeTi cruise of R/V 'Alis' has surveyed the southern tip of the North Fiji Basin (SW Pacific), where the backarc spreading centre propagates south into the junction of the Vanuatu Arc and Hunter Ridge. At this location the Vanuatu Trench terminates and swings northeast at the right angle into the facture zone along the Hunter Ridge(3). The cruise sampled two young, previously unknown underwater volcanic centres located on the arc crest along the southern continuation of the propagating spreading centre across the arc. Low-Ti tholeiitic picrites comprise the southern seamount. They have (La/Sm)N=1, positive LILE and negative HFSE anomalies typical of subduction-related lavas. Olivine phenocryst compositional range is Fo83-94; spinel CrN=85-75. These rocks are in many respects similar to the Troodos UPL.

High-Mg andesites from the northern seamount are slightly more enriched, (La/Sm)N=2, but also have typical subduction-related geochemistry. They

have phenocrysts of olivine (Fo 80-93.5), clinopyroxene (MgN 80-91) and microphenocrysts of plagioclase (An 88- 92); spinel CrN = 80-25. These rocks resemble in many respects the Troodos LPL.

Although not being identical to the UPL/LPL association of Troodos, the picrite/high-Mg andesite assemblage of the southern Hunter Ridge shares many characteristic features with the Troodos magmatic section, including close spatial and temporal coexistence of distinct mantle sources. The source of picrites is significantly more refractory as indicated by the compositions of Cr-spinels. Another broadly contemporaneous combination of lavas with a pronounced subduction geochemical signal but originated from variably refractory mantle sources has been described from the NE Lau Basin(4), where the backarc spreading centre propagates towards the northern termination of the Tonga Trench.

We suggest that SSZ settings where backarc spreading propagates into the forearc region, also characterised by the subduction-transform fault transition, are the likely places for the formation of the Troodos-type SSZ ophiolites. Transition from subduction to transform tectonics forms a side "window" which allows hot mantle from under the slab to penetrate the mantle wedge, providing a source for the hotter, more refractory magmas. Trench roll-back, usually associated with these settings, creates an extensional regime and provides a further "incentive" for the intrusion of the hot mantle. At the same time, propagating backarc spreading provides a source for the ess-refractory magmas.

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T52D-06 1450h INVITED

Processes of Ophiolite Genesis and Emplacement in the Nascent Collision of Asian and Northern Australia

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The shouldering of northern Australia into subduction zones of SE Asia provide several examples of the development and tectonic emplacement of ophiolites in zones of pericollisional extension. Extension, in most cases, is driven by trench roll-back and lateral extrusion at the edges of nascent collision zones. These young ocean basins are immediately incorporated into forward and lateral propagating collision zones. Mature ocean basins remain mostly in tact and become trapped within a collage of arc terranes, such as the Sulu basin. Younger ocean basins and the arcs mounted on them are commonly thrust over continental margins, such as in the Banda arc-continent collision. Reversal of subduction polarity plays an important role in isolating oceanic and arc affinity terranes in collision zones. This process is observed at various stages of development along the northern margin of Australia producing a variety of ophiolite masses, some as large as the ophiolite of northern Oman. The active tectonic setting of the region provides a way to link many of the ophiolite bodies with the different plate boundary configurations that produced and detached them.

T52D-07 1525h

Northwestern Australian Collision in the Timor Sea: Constraints From Flexurally-Induced Normal Faulting.

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Since latest Miocene to Early Pliocene partial subduction of the northwestern Australian continental margin beneath the Eurasian plate produced an early stage foreland basin in the Timor Sea. Pre-Miocene superimposed thin and thick skinned structural styles, are equally affected by the collision of the continental crust with the Banda Arc. Flexural extension due to the bending of the Australian plate resulted in the reactivation of numerous earlier normal faults. These reactivated structures document the oblique, rotational clockwise, southeastward nature of the convergence. Over 500 kilometers of 2D seismic data and well information record the geometry and character of the flexure-induced normal faults. Over 200 of these faults were studied. Earliest Pliocene fault slip decreases about 35 % from west to east from 11.95 ms (Approx. 30 m) on average in the south west (Vulcan basin area) to 7.86 ms (Approx. 19.5 m) in the north east (Sahul platform area). Conversely, late Pliocene fault slip increases about 28 % from 6.47 ms (Aprox. 17 m) on average in the south west (Vulcan basin area) to 8.3 ms (Approx. 21 m) in the north east (Sahul platform region). Rheologic analysis indicates that the Vulcan basin area has undergone more total deformation as indicated by the higher total offset of faulting within the sedimentary foreland sequence. However, since Late Pliocene the Sahul platform area has undergone about 10 % more deformation as indicated by the average slip in the flexural faults. Collision, then, probably occurs in a clockwise sense beginning south of Timor Island and continuing later toward the Tanimbar Island region in the north east. Tomographic images of the mantle in the area corroborate the enhanced amount of subduction of the southwestern region compare to the north east. Simple elastic models predict greater bending stresses toward the Timor trough. The expected increase in deformation toward the trough is manifested by an increase in fault density rather than an increase in fault slip within the Pliocene section. Flexure-induced normal faults affecting present day sea floor are distributed in an area within 50 to 150 km of the tectonic wedge front (Banda Arc). Pliocene faults were located at least 100 km further away from the active tectonic wedge (i.e. >250 km). This difference in the spatial distribution of faults indicates a change in the rheologic regime of the lithosphere over time. Heterogeneous elastic thickness of the lithosphere in the area is causing a concentration of stresses on the modern narrow zone of high deformation. Also the fall in the rate of convergence (from 70 km/m.y. during Pliocene to about imperceptible today) reduces the amount of transferable stress into the continental plate

T52D-08 1540h

Geochemistry and Sm-Nd dating of garnet peridotites from Central Sulawesi, and its implication to the Neogene Collision complex in Eastern Indonesia

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Orogenic garnet-bearing peridotites occur on the island of Sulawesi, Indonesia. They are distributed in two regions within NW-SE trending strike-slip fault zones. Garnet lherzolite within the left-lateral Palu-Koro fault zone occurs as < 10 m wide fault slice associated with high-grade metamorphic rocks in a Miocene granite; whereas within the right-lateral Ampana fault in the Bongka river valley, the peridotite occurs as 10-30 m wide, fault-bounded outcrops juxtaposed against gabbro and peridotites of the East Sulawesi ophiolite. Analysed lherzolites are generally depleted in SiO2, TiO2, Al2O3, CaO and Na2O, and enriched in FeO total and MgO; trace elements of Y and Zr decrease, while Ni increases with increasing MgO. These values are consistent with an origin as a depleted mantle residue rather than forming as a crustal cumulate. Whole-rock REE patterns from hydrous phase rich rock show LREE enrichment. However, the reconstructed whole rock REE patterns based on modal reconstruction ion probe analyses of garnet and pyroxene are flat and slightly depleted in LREE. The differences between the reconstructed whole rock REE pattern and the analyzed whole-rock REE pattern, indicate that the Sulawesi garnet peridotite has undergone both modal metasomatism and trace element enrichment resulting in the formation of pargasite and/or phlogopite. Furthermore, a P-T time plot suggests a prograde subduction zone peridotite. After a peak stage, the garnet peridotite suffered intensive mantle metasomatism and hydration which indicate a mantle wedge environment above a subduction zone. Sm-Nd dating has yielded mineral ages of 27-20 Ma. 27 Ma is probably the time of peak metamorphism and 20 Ma is the cooling age. The young ages do not support the previous idea that garnet peridotites are a part of Mid Cretaceous UHPM terrane. However, the Neogene age is similar to a recently reported age of the country rock schist and gneiss. Therefore, the ultramafic rocks are most likely were introduced into the crust and metamorphosed to garnet bearing assemblages during Late Oligocene Early Miocene continent-continent collision in Central Sulawesi (e.g. Sundaland and fragment of the Australian continental margin). In reality, the Neogene collision in Sulawesi is a very complex collision involving accretion of SW Pacific superplume-induced ophiolite massif, high-pressure metamorphic rocks, volcanic arc and continental fragments, and then followed by an extension. The geochemical and petrological data suggest that the peridotite is a mantle wedge fragment that has experienced HP metamorphism, and subsequent metasomatism from the subducted slab, and later somehow incorporated into the underthrust continental crust. Due to the buoyancy force of delamination of a crustal slab from the oceanic lithosphere, the peridotites were uplifted within the Neogene metamorphic complex, suffering a similar decompression as that experienced by the regional schists and gneisses. Final exhumation from an upper crustal level was facilitated by entrainment in Late Miocene granitic plutons, and/or transtension in deep-seated strike-slip fault zones.

T52D-09 1555h

Papuan Ultramafic Belt (PUB) Ophiolite: Field Mapping, Petrology, Mineral chemistry, Geochemistry, Geochronology, And Experimental Studies Of The Metamorphic Sole

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The Papuan Ultramafic Belt (PUB) ophiolite in Papua New Guinea (PNG) is a large and well known section of former oceanic crust and upper mantle exposed in the western Pacific region. The PUB ophiolite was emplaced onto the southeast PNG continental crust possibly in the early Cenozoic . Detailed west-east transects during field mapping in the Musa-Kumusi divide area has shown that the Emo Metamorphics grade into amphibolites which grade up into the granulites which grade up into or are in contact with the ultramafic base of the PUB ophiolite. The ultramafics at the base of the PUB consist of harzburgites, and banded peridotites consisting of lherzolite, pyronenite and harzburgite layers. The harzburgites in the ultramafics have Fo92 olivine but there are small and correlated differences in Cr/Al ratio of both spinel and orthopyroxene and in CaO content. The pyroxenes in the lherzolite are very Ca-rich diopside and co-existing orthopyroxene with low CaO content, but higher than that of orthopyroxene in harzburgite. Temperature of equilibration by two pyroxene thermometry is 814-865oC, at 3 kbar. Hornblende is the dominant mineral phase in the granulites and amphibolites coexisting with olivine, orthopyroxene, clinopyroxene, plagioclase, ilmenite, magnetite. Lower SiO2, CaO, Al2O3 and higher MgO, TiO2, (Na2O+K2O), P2O5 contents of the granulites and the high MgO content and normative olivine (10%) suggest that the sole granulites are essentially picritic in composition and are similar or transitional to the basic rocks of the Emo Metamorphics, and differ from the gabbroic rocks of the PUB ophiolite in lower TiO2, lower Na2O, higher Al2O3, lower FeO and lower P2O5 of the PUB, at similar MgO contents. A conventional A K-Ar, 40Ar-39Ar total fusion and incremental step-heating 40Ar-39Ar geochronological study on the metamorphic sole using amphiboles from emplacement-related granulites and amphibolites have been concluded. Sandwich melting experiments have been conducted to understand the mechanism for generation of boninite melts within the mantle wedge above subduction zone. Eruption of the Cape Vogel boninites and the emplacement of the PUB ophiolite and the formation of the metamorphic sole occurred in the Paleocene between 60 Ma to 58 Ma.

T52D-10 1610h

Oldest ophiolite - 2.8 Ga boninite series of a supra-subduction zone ophiolite from the North Karelian greenstone belt, NE Baltic Shield, Russia

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Late Archean subduction-related assemblages of the North Karelian greenstone belt, NE part of the Baltic Shield, Russia, reveal the oldest known boninite series occurring at least in two area of the belt. The first area referred to here as the Khizovaara structure shows apparent evidence of a late Archean ocean-island volcanic arc collage formed during two distinct tectonic episodes nearly 2.8 Ga ago. The second area named as the Iringora structure discloses unique features of an ophiolite stratigraphy, including not only gabbro or lava units, but also remnants of a sheeted dike complex. The major and trace element chemistry of the Iringora ophiolitic gabbro, dike and lava units suggests a comagmatic series with a continuous compositional variation from more primitive mafic to strictly boninitic melts. In terms of major- and trace element abundance, the boninite series of the North Karelian greenstone belt is practically indistinguishable from the Group I and II of the Troodos upper pillow lavas defined by Cameron (1985). These occurrences strongly suggest that late Archean subduction-related processes evolved boninite-hosting SSZ ophiolites have not changed substantially over the past 2.8 Ga.

URL: http://geo.tv-sign.ru/present/karelia/FrameSet.htm

T52D-11 1625h INVITED

Tectonic implications for the occurrence of ocean floor, hotspot, and island arc materials within accretionary prisms: Examples from the Mesozoic-Cenozoic NW Pacific Rim

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On-land Mesozoic-Cenozoic accretionary prisms exposed in Japan commonly have basaltic rocks incorporated as blocks into melanges or fault zones during a prolonged history of subduction and/or obduction. Chemical signatures of these basaltic rocks and their mode of occurrence with sedimentary covers and/or associated sedimentary rocks indicate that most of these isolated small basaltic blocks consistently display a WPB chemistry, whereas large slabs of basaltic rocks around the Izu Arc collision zone show MORB chemistry with rare examples of IAT, BABB, and/or WPB affinities. Comparing with the present uniformitarian examples of convergent plate boundaries in the western Pacific that we know through the DSDP and ODP projects and submersible and seismic surveys, we can interpret some of the basaltic material with WPB affinity in the Japanese accretionary prisms as relict edifices of seamounts with hotspot origin. These hotspot-related basaltic rocks are commonly associated with reefal limestones and were incorporated into continental margin melanges either by submarine sliding from the downgoing oceanic plate or by shallow-level off-scraping along decollement surfaces during the subduction of oceanic plates. Older, uplifted parts of the fossil accretionary prisms on the continent side further inward from the trench where the deeper levels of accreted material are exposed include larger amounts of basaltic blocks. This observation suggests that significant amount of underplating might have occurred in the deeper levels of oceanic crust along decollement zones at structurally lower depths. The metamorphic belts (e.g.Sambagawa, Chichibu, Shimanto etc.) have commonly alkaline rocks or plateau-type E-MORB basalts without any trace of N-MORB rocks with rare special exceptions.

Besides these ordinary accretionary prism examples formed by a simple plate subduction system, another type of accretion resulting from island arc or ridge collision is observed to have occurred in both the eastern and western Izu Arc collision zone since the Miocene. The arc/ridge collision caused the incorporation of a particular assemblage of basaltic rocks in this tectonic accretion system which we interpret as an ophiolite. These gophiolitich rocks are composed of various types of basaltic to rhyolitic, effusive and intrusive, dismembered, disrupted, sheared and faulted rocks that are locally associated with some hotspot and island arc igneous rocks and pelagic sedimentary rocks. This ophiolite assemblage is widely distributed particularly in the trench-slope break or within the forearc sliver boundary in the Circum Izu region. Deformation and metamorphism in these settings are weaker at shallower levels than those in the accretionary prisms, other than the Izu Arc collision zone. Based on these examples from Japan, we infer that ocean floor, hotspot, and island arc rocks become accreted into active continental margins either through ordinary subduction-accretion processes in a non-collisional subduction system or by obduction-accretion processes in a collisional island arc system.

T52D-12 1640h

Multi-stage Evolution of the Tertiary Mineoka Ophiolite (Boso Peninsula, Japan) at a TTT Triple Junction in the NW Pacific as Revealed by New Geochemical and Age Constraints

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The Pacific, North American, and Philippine Sea Plates are adjoined at a TTT-type triple junction 350 km SE of the Boso Peninsula in central Japan where the Japan, Izu-Bonin, and Sagami Trough Trenches intersect. The Mineoka ophiolite, outcropping in the southern Boso Peninsula, has been situated in a unique tectonic setting in the Izu Arc collisional zone on the SE-concave Honshu Island since the middle Miocene. We discuss the mode of occurrence, geochemistry, and radiometric ages of the basaltic and other igneous rocks from the Mineoka ophiolite to verify the origin and tectonic implications of these rock assemblages. The ophiolitic rocks are composed mainly of tholeiitic pillow basalts and doleritic sheeted dikes, alkali-basaltic sheet flows, and calcalkaline dioritic to gabbroic plutons. The tholeiitic basalts show variable trace-element compositions ranging from mid-oceanic ridge to island-arc type. The alkali-basalts have a within-plate affinity. Ar-Ar and K-Ar dates yield ages of 40-50 Ma and 110 Ma for the tholeiitic basalts, 20 Ma for alkali-basalts, and 20 to 40 Ma for the calcalkaline plutonic rocks. These age brackets are inconsistent with the known ages from the Pacific or the Philippine Sea Plates; we therefore infer that the Mineoka ophiolitic assemblage was part of an oceanic plate, called the gMineoka Plateh. The Mineoka Plate underwent an island-arc volcanism in the Miocene as a result of subduction initiation at a fracture zone or a transform fault system due to a change in the position of the Euler rotation pole of the Pacific Plate 43-42 Ma. Rift volcanism associated with back-arc basin opening might have occurred within the Mineoka Plate shortly after the establishment of this subduction zone. Eruption of within-plate-type alkali basalts in the ophiolite likely took place near the paleo-Honshu continental arc just before the emplacement of the Mineoka ophiolite into the Japanese continental margin.

T52E MC: 310 Friday 1330h

Nankai Seismogenic Zone: GPS, Earthquakes, Relection Seismology, and Comparisons to Costa Rica *(joint with OS, S)*

Presiding: **H Mikada,** Japan Marine Science and Technology**; S Schwartz,** UC Santa Cruz

T52E-01 1330h INVITED

Crustal deformation along the Nankai Trough through an entire earthquake cycle: a retrospective view with present GPS data

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Crustal deformation along the Nankai Trough provides one of the most complete deformation records associated with an earthquake cycle at subduction zones. Triangulation and leveling surveys starting from the late 19th century have revealed typical coseismic, post-seismic, and interseismic deformation related to plate boundary megathrust events. In addition, recently deployed Japanese nationwide continuous GPS array (GEONET) provides very precise information about an interseismic strain accumulation process. Not only horizontal but also vertical displacement rate is estimated at every GPS site, showing landward motion and inland uplift due to interplate locking. More importantly, daily coordinate solution has revealed that interseismic deformation is not perfectly steady and at least two episodic slow slip events have occurred along the Nankai Trough recently.

I will overview the spatio-temporal pattern crustal deformation during the last earthquake cycle based on conventional geodetic survey data and recent continuous GPS data. Present GPS-derived interseismic deformation pattern resembles those derived from conventional geodetic surveys in old days. But the GPS data yields smaller (about 60%) angle change rates of the triangulation network than the old data, implying time-dependent deformation rate changes and a possibility of episodic deformation events. GPS-based uplift data shows wider uplift areas to further inland compared with previous leveling results. Recently slow thrusts event with a duration of more than several months are found around the Bungo Channel (Hirose et al., 1999) and in the Tokai district (Ozawa et al., 2001). I review old triangulation as well as leveling data in the light of these new findings. Especially after the 1946 Nankaido earthquakes, postseismic deformation with a time constant of 5-30 years was found in and around the Shikoku island. On the other hand, Kimata and Yamauchi (1998) reported periodic changes in baseline shortening rates every 6-8 years in the Tokai area. These old observation can be interpreted as a result of slow slip events. It is reasonable to assume these slow events have repeatedly occurred in the past. These new findings are crucial to a proper understanding of the deformation cycle along the Nankai Trough.

T52E-02 1345h

A Possible Precursor of an Anticipated Subduction Zone Thrust Earthquake in the Tokai Region, Central Japan, Detected by a Continuous GPS Network Measurements

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The Tokai region is located along the Pacific coast of central Japan and about 200 km to the south west of Tokyo. The Suruga trough, a subduction plate boundary between a continental plate and the Philippine Sea Plate, runs just off shore of this area. This region is a well known seismic gap along the Suruga-Nankai trough. Continuous GPS data since 1994 and historical geodetic survey data for about 100 years consistently suggest a steady strain accumulation in this region until recently. Since the beginning of 2001 we detected a change in crustal deformation rates around the Tokai