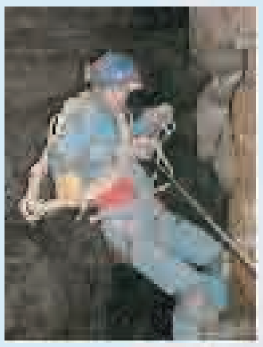
AOB Seminar

Date & Time: September 25, 2007
Place: Meeting Room #1, AOB Anex

Lecturer & Title & Abstract



Prof. Bradley R. Hacker (University of California, Santa Barbara)

・Lecturer1 9:30-10:15

「H_2O Subduction Beneath Arcs: Implications for the Global H_2O Cycle, Arc Magmatism, and Subduction Erosion」

--- Abstract ---

The amount of H_2O subducted to subarc depths dictates such disparate factors as the generation of arc and back-arc magmas, the rheology of the mantle wedge and slab, and the global circulation of H_2O. Perple_X was used to calculate phase diagrams and rock physical properties for pressures of 0.5-4.0 GPa and temperatures of 300-900℃ for a range of bulk compositions appropriate to subduction zones. These data were merged with global subduction-zone rock fluxes to generate a model for global H_2O flux to subarc depths.

For unmetasomatized igneous rocks, subducted H_2O scales with Mg/Si in cold subduction zones, whereas the rock composition does not impact the subarc H_2O in hot subduction zones. For metasomatized igneous rocks, subducted H_2O scales with initial H_2O content in cold subduction zones, and with bulk-rock K_2O in hot subduction zones. Metasomatized ultramafic rocks behave similarly in cold subduction zones, but in hot subduction zones carry no H_2O to magma-generation depths because they lack K_2O. Chert and carbonate are responsible for minimal H_2O subduction, whereas clay-rich and terrigenous sediments stabilize several hydrous phases at low temperature, resulting in significant subarc H_2O flux in cold and hot subduction zones. Continental crust also subducts much H_2O in cold subduction zones due to the stability of lawsonite and phengite; in hot subduction zones it is phengite that carries the bulk of this H_2O to subarc depths.

All told, the flux of H_2O in cold subduction zones is dominated by terrigenous sediment and metasomatically altered igneous rocks and is proportional to bulk-rock H_2O. In contrast, in hot subduction zones the major contributors of subarc H_2O are altered volcanic rocks and subducted continental crust, with the amount of subarc H_2O scaling with K_2O. The Tonga and Makran slabs are the principal suppliers of pelagic- and terrigenous-sediment hosted H_2O to subarc depths, respectively. The Chile and Solomon arcs contribute the greatest H_2O flux from subducted continental and oceanic forearc, respectively. The Ryukyu arc has the greatest H_2O flux provided through subduction of altered ocean crust and mantle. No correlation was observed between subarc H_2O flux and arc magmatism or seismicity.

・Lecturer2 10:15-11:00

「Continental Relamination Drives Compositional and Physical-Property Changes in the Lower Crust」

--- Abstract ---

A long-standing paradigm for the genesis and evolution of Earth's continental crust holds that the crust is andesitic and reached this composition in the 'subduction factory' by delamination or foundering of a dense, mafic or ultramafic component into the mantle from the base of initially basaltic arc crust. However, the range of suggested compositions for the lower crust and our incomplete understanding of subduction-zone processes render this paradigm non-unique. Recent discoveries from (ultra)high-pressure xenoliths and terranes, combined with re-evaluation of methods for inferring lower crustal compositions from seismic velocity data, show that "relamination" of buoyant, subducting continental crust may be an efficient means of altering the composition of the lower crust.

Ultrahigh-pressure terranes show that large areas (>60,000 km²) of continental crust are subducted to depths >100 km where they undergo heating to temperatures of 600-1000℃ for periods of up to 20 Myr. Xenoliths from the Pamir show that subduction erosion can drag continental rocks to depths >90 km and temperatures of ~1200℃. In both settings, devolatilization and melting transform cold, hydrous, low-density crust into hot, less hydrous residues. Felsic and intermediate rocks attain densities similar to the middle-lower continental crust; buoyancy may drive such rocks to rise through the mantle to pond at the Moho or higher crust levels. The calculated seismic wavespeeds of such material are indistinguishable from the bulk lower crust. Both ultrahigh-pressure continental subduction and subduction erosion operate at rates of 1-1.5 km³/yr, such that over the lifetime of Earth either could have led to large-scale 'continental relamination', refining the composition and physical properties of the continental lower crust.

利根川 貴志 博士 - Dr. Takashi TONEGAWA - （東京大学地震研究所）

・Lecturer3 11:15-12:00

「太平洋プレート表面の地震波速度コントラスト −マントル遷移層への水輸送の可能性− (Seismic Velocity Contrasts at the Top Surface of the Subducting Pacific Slab ; Implications for Water Flow Into the Mantle Transition Zone)」

--- Abstract ---

It has recently been proposed that the mantle transition zone is a water reservoir in the Earth's interior. Several experimental researches have shown that transition zone minerals, such as wasleyite and ringwoodite, can contain significant amounts (~several wt%) of water in the crystal structure, whereas the solubility of water in olivine is less than 0.2 wt%. Hydrous minerals above and inside the subducting slab may play an important role to carry water into the mantle transition zone. To image seismic velocity contrasts at the upper mantle discontinuities including the subducting Pacific slab, we applied receiver function (RF) analysis to the Hi-net tiltmeter recordings.

Usually, radial RF is stacked to image seismic discontinuities. In this study, however, we also used transverse RF, which is effective for detecting P-to-S phase converted at a dipping layer, by limiting back azimuth of the teleseismic events between 120° and 180° This limitation allows us to combine radial RF with transverse RF in seismic imaging. We applied a bandpass filter of 0.02-0.16 Hz, and CCP (common conversion point) stacking for imaging.

We present a receiver function image of the subducting Pacific slab with undulations of both the 410 km and 660 km discontinuities beneath the Japanese Islands. Especially, the top surface of the Pacific slab indicated by positive RF amplitudes can be seen down to the mantle transition zone, implying that the subducting slab is faster than the mantle wedge in seismic velocity. In synthetic forward modeling, the seismic contrast for the top slab surface is approximately 8-10 % at depths 200-300 km. This would be attributed by the existence of hydrous minerals on the slab, and those minerals possibly carry water into the mantle transition zone.

Furthermore, in addition to top slab surface, we could also image the uplift of the 410 km discontinuity. This means that we could successfully identify both the top slab surface and the 410 km discontinuity at depths of 300-400 km.

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