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The Moho

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Travel times from a Balkan Earthquake, recorded by the first generation of European seismograph stations, convinced Andria Mohorovičić in 1909 of a major boundary at a depth of about 50 km. He had observed a significant jump in P-and S-waves which was later confirmed by more seismological observations from Benno Gutenberg, still in Frankfurt in the early 20ies. The advent of seismic refraction recording from large explosions in the late 40ies (e.g. the detonation of Heligoland in 1947) marks a step in the research regarding Mohorovičić's discontinuity. The "Moho" was recognized worldwide to be the crust – mantle boundary, present under the continents and below the oceans. It is indicated by refracted waves, like P_n and S_n and wide-angle reflections, like $P_M P$ and $S_M S$. Multiphase events suggested a complex boundary. In the early 1960ies near-vertical reflection techniques, mainly in P, opened a new chapter of Moho-research. Combinations with improving refraction work, now called "Explosion Seismology" or "Deep Seismic Sounding" (DSS) revealed more and more details about the Moho, based on different frequency (and wavelength) content and orientations of the two methods. Near vertical studies often shows the crust , and especially the lower crust, full of reflections, some of them even "laminated" in special tectonic environments. The Moho very often appears only as the end of reflectivity, not as an outstanding reflection. Because its energy is comparable to that of deep crustal reflectivity, many researchers assume a stepwise transition over about 10 km, the Moho only being the last (small) step. This situation is explained by a hot generation. Numerous mafic-ultramafic intrusions from the upper mantle may give rise to significant impedance contrasts and discontinuities inside a more felsic matrix, sometimes even forming lamellae under extensional stress and strain. It is a matter of definition if we consider the Moho to be a thick transition zone or to be just the last reflections before the homogeneous and reflection-poor mantle is reached.

Petrological studies of xenoliths have established the Moho to be the boundary between mafic- felsic rocks in the crust and ultramafic rocks with a high percentage of olivine in the upper mantle. Occasionally, as in subduction zones and deep Mohos, a transformation of lower crustal rocks like gabbro into eclogite (with mantle velocity) might occur, hereby placing the “true” (petrological) Moho below the seismic Moho.

Differences in density, viscosity and conductivity have been modeled in order to confirm the Moho as a prominent boundary. Even differences in seismic anisotropy due to preferred mineral orientation have been observed. Toward the end of the last century a new seismological technique, the “receiver function method” was created, using P-S conversion of teleseismic rays at the Moho in order to get a low-frequency image, in a way similar to a reflection seismogram. In summary, the Moho is found to be a sharp, a stepwise, or even a smooth transition from felsic or mafic crustal rocks (in places eclogotic) to olivine-dominated ultramafic rocks of the upper mantle.