The formation of calcium perovskite from majoritic garnet – Implications for splitting of the 520 km seismic discontinuity

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Global seismic observations show complexity in the region of the 520 km seismic discontinuity (Deuss and Woodhouse 2001). In some regions of the mantle this discontinuity seems to be split into two discontinuities at approximately 500 km and 560 km. In addition to the wadsleyite to ringwoodite transition, the exsolution of calcium perovskite (Ca-Pv) from majoritic garnet (gt) may be capable of producing a seismic discontinuity. This, however, would require the reaction to occur over a sufficiently narrow depth interval and to cause a significant change in elastic properties.

We have experimentally studied the calcium perovskite forming reaction in high pressure and temperature multi anvil experiments to determine if it is likely to cause an observable discontinuity. Experiments were performed by equilibrating Ca-free majorite gt with Ca-Pv to determine the saturation level as a function of pressure, temperature and garnet majorite content i.e. (Al/Mg+Si).

Experimental results show that because the reaction results in a strongly non-linear yield of Ca-Pv with pressure, a significant portion of the reaction is completed over a quite narrow initial depth interval. The sound velocity changes over this interval for a fertile peridotite composition are smaller but of a similar magnitude to those of the wadsleyite-ringwoodite transition and would likely cause a weak discontinuity at approximately 560 km in line with seismic observations. If, however, the mantle contained a significant component of recycled basaltic crust the higher mantle Ca contents would result in a much stronger discontinuity. For this reason the feature observed at 560 km will be sensitive to the proportion of basaltic components in the mantle at transition zone conditions and is therefore an indicator of chemical heterogeneity.

References

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Fulgurites from Garuamukh, Assam, India – FTIR spectroscopic study

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There are two phenomena that are responsible for making natural glass on Earth: meteorites and lightning. Glass that is made as a result of the collision of a meteorite with the Earth's surface is called meteoritic glass or tektite. Glass (a glassy object, to be exact) that is made as a result of a cloud-to-ground lightning discharge is called a fulgurite (from the Latin "fulgur" which means lightning). Fulgurites come in a great variety of forms and can be viewed as nature's own works of art. It is worth noting that lechatelierite (natural silica glass) is not present in obsidian, a glass-like material associated with volcanic activity. On the other hand, volcanic activity is known to generate lightning which, if it strikes sandy soil, may produce a fulgurite.The black-brown natural glass found at Garuamukh near Nagaon town (Lat.26º19´N, Long. 94º30´E, Assam, India) is due to the fourth category of formation . The colloidal material comes out from the earth’s surface making a number of branching with fire and foul odour smoke and the upper part of it is gradually solidified to natural glass within a few hours. The solid material have been found to have a temperature of about 80 ºC even after a lapse of two days after occurrence of the event whereas the room temperature during that period was 28 ºC. The increasing of temperature is observed on the spot with the increasing of depth. In order to understand the possible meteoritic or fulgurite origin of the glassy materials, we made an attempt to characterize the sample by using FTIR spectroscopy, and powder x-ray diffraction. The present investigation of the naturally occurring glass sample reveals the characteristic features of amorphous silica with some other minerals as trace. As the structural change taking place in the octahedral symmetry in the formation of the sample so, the possibility of producing this silicate glass is by ultra high- temperature that is higher than the corresponding fusion point of the crystalline state, indicating the nature of a fulgurite.