Mineralogical and chemical variations in kaolin and alunite deposits in vicinity of the Aksaray region (Central Anatolia, Turkey)

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The kaolin-alunite deposits were formed in Lower Miocene volcanic and volcanoclastic, mostly dacitic, rhyodacitic, and andesitic rocks. The deposits were derived from by supergene and hypogene alteration processes. Kaolinite/halloysite is clay minerals, sometimes pure and sometimes associated with α-quartz, K-feldspar, plagioclase, alunite, natroalunite and hematite, whereas other kaolinite accompanies smectite, which represents a moderate kaolinization. Massive zones of alunite deposits sometimes pure, and show gradational passing to kaolinite/halloysite, and they were cut by gypsum and native sulphur veins and contain partially cinnabar and realgar mottles and/or veinlet. Tridymite and rarely low-cristobalite are the dominant silica mineral in these kaolins. Barite, pyrophyllite, minamiite, hematite, and geotite/lepidocrosite are rarely observed. Bentonite deposits composed mainly of nearly pure Ca-montmorillonite, observed as gradually or sharply at the uppermost levels or lateral sides of the alunite and kaolinite deposits. The alunite and most of kaolinite are products of hypogene alteration. Alunite, kaolinite, and gypsum samples show very similar chondrite-normalized REE trends, suggesting that they may be linked to common source. The REE patterns of the alunite and kaolinite samples are characterized by strong LREE enrichment ((La/Lu)cn=54.7 and 170.5, whereas gypsum and bentonite samples show moderate enrichment (9.2 and 7.2), respectively. Most of the alunite and kaolinite samples have pronounced positive Eu anomalies (1.08) and gypsum and bentonite samples negative and/or weakly negative Eu anomalies ranging from 0.77 to 0.89. All of the samples have positive Ce anomalies. Alunite and native sulphur samples from the deposits have $\delta^{34}S$ values of 5.03-6.62%, and 5.97-7.49%, respectively, with values for gypsum of 4.5-5.24%. Therefore, the sulphur-rich minerals may have been formed by steam-heated hydrothermal environments. The isotopically slightly heavy sulphur in the minerals could be derived from H_2SO_4. Development of the hydrothermal alteration contemporaneous with extensional tectonic and strike-slip faulting movements have resulted in hypogene alunite and kaolinite deposits. Hydrothermal alteration strongly affected along fault zones but subsequent weathering (supergene) away from the fault zones, and much of the volcanoclastic rocks have been altered to a more smectite-rich and less kaolinite-bearing assemblage.

A new model of the asthenosphere

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Although the classic model of asthenosphere = a layer of partial melt has been questioned for more than two decades, such a model is revived recently based on seismological observations showing a sharp and large reduction in seismic wave velocity. In this presentation, I will argue that such a model is not consistent with physics of behavior of partailly molten materials nor with the seismological observations. First, in the gravity field, it is difficult to maintain a substantial amount of melt for a geologic time scale. Layering observed in some lab experiments is often invoked to explain the persistency of a mlet-rich layer, but the lab experiments show ~20° tilt and hence the melt-rich layer will be compacted. Second, if a large reduction of velocity (~5-10%) were to be due to the presence of sub-horizontal melt-rich layer, then the asthenosphere should show large anisotropy in SH/SV waves (5-10%), which is not observed.

I propose that the basic properties of the asthenosphere is best explained as a residue of partial melting near the 410-km discontinuity. Partial melting removes a large fraction of incompatible elements leading to the 'depleted' homogenous composition, and also leads to ~0.01 wt% of water in the asthenosphere. The lab data show that this much of water is consistent with the observed electrical conductivity of the asthenosphere including its regional variation. If water reduces the strength of grain-boundaries, it can easily exlpain the sharp drop in velocity as much as ~10%.