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Mineralogical features and properties of serpentine as indicator of the deep earth subduction processes

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Serpentine is a polygenic mineral which is formed under various geological conditions. The latest data show that serpentine can be regarded as reference point of deep mantle and subduction processes (IMA-2010). The obtained experimental data show that elastic characteristics of minerals change depending on phase composition of serpentine. That information can be used for the interpretation of geophysical data and our knowledge of the deep structure of a lithosphere. From this point of view it is actual to study different samples of serpentine from various deposits and detect features of the minerals formed at high pressures and temperatures.
Researches were carried out in laboratories of geological faculty of the Lomonosov Moscow State University and included the following methods: IR-spectroscopy, X-ray analysis, scanning electronic microscopy, microbeam analysis, differential thermal analysis, etc. We studed different physical properties of the selected samples (volume density, velocity of the elastic waves, microhardness, magnetic susceptibility) and the modules of the deformations were calculated. The following samples were selected for comparative researches:
• brown serpentine with a streaks of opal and inclusions of pyroaurite from the alteration products of the maphic rocks (N4);
• yellow noble serpentine with chrysotile-asbestos streaks from magnesian metasomatic carbonates (N7);
• noble light green serpentine (ophiocalcite, N9);
• green serpentine with a visible large layers of chrysotile-asbestos from Bazhenovsky deposit (Urals, N10);
• black serpentine with mica and layers of lizardite from metasomatic chromite-bearing pyroxenites (Urals, N14)
According to termogravimetric analyses and IR-spectroscopy data we divided the serpentinites into 3 groups.
1. Lizardite prevails in samples from Nurali (N 8) and Bazhenovsky (N 10).
2. Antigorite prevails in samples of light green (N 9) and yellow (N 7) noble serpentine.
3. Clinochrysotile prevails in samples of dark serpentine (N 4, 14).
Features of structure of serpentinite were studied by the optic and SEM microscope. As a result of the researches 2 groups of the samples were divided.
1. Serpentinitic particles don't form oriented texture. They form a complex fibrous-plates structure (8, 9, 4). The sizes of the particles are differed. They are visible at increase ranging from 700 up to 30 000.
2. Chrysotile forms an oriented layers of various thickness (7, 10, 14)/
Chemical composition was studed and serpentinites were divided into following groups:
• N10, 8 - high Al ($Al2O_3 > 0.6$ wt %); high and middle Cr ($r2O_3 > 0.45$ wt % and from 0.1 up to 0.4 wt %).
• N 9, 7 - low Al ($Al2O_3 < 0.1$ wt %) and low Cr ($r2O_3 < 0.05$ wt %).
• N 14 - middle Al ($Al2O_3$ from 0.3 up to 0.5 wt %) and low Cr ($r2O_3 < 0.05$ wt %)
Serpentinites of the first group have an ultramaphic protholites and are formed at the upper mantle. Serpentinites of the second group have a carbonate protholites and are formed near the surface of the Earth. Serpentinites of the third group have a maphic protholites and are formed in the lithosphere.
Physical properties of serpentines were studed.
The maximum hardness (816-1111 g/mm2) was found in noble light green antigoritic serpentine (9). The minimum hardness (21 g/mm2) has green serpentine with clearly distinguishable streaks of asbestos from the Bazhenovsky deposit (10) and yellow noble antigoritic serpentine with asbestos streaks (7) from magnesian metasomatic carbonates.
The minimum volume density (2.4 g/sm3) was discovered in a sample 4 - brown serpentine with the opal and numerous fluid inclusions. The maximum volume density (2.87 g/sm3) has a sample 14 - black serpentine from metasomatic chromite-bearing ultramaphic rocks.
The minimum velocity of the elastic waves (Vp = 1.2 km/sec; Vs=0.6 km/sec) was detected in a sample 4 – clinochrysotile with the opal. This sample has a minimum value of the calculated modules of the deformations (1.0 and 2.6 GPa).

The maximum velocity of the elastic waves (Vp = 4.5 km/sec; Vs=2.6 km/sec) was discovered in a sample 9 – antigorite from noble green ophiocalcite. This sample has a maximum value of the calculated modules of the deformations (17.3 and 43.6 GPa).

We compared our results with literary data (Bezacier et al, 2010). Values of Vp for our samples are close to the values received earlier for aggregates of antigorite. Values of Vs for our samples are much lower, than ones measured earlier. Anisotropy also is different. Especially significant differences are observed for samples 4 and 10. They are associated with presence of the opal (4) and an abundance of streaks of chrysotile-asbestos in a lizarditic matrix (10). Physical parameters of the antigorite-bearing samples (9 and 7) are closest to the constants received by Brillouin spectroscopy method.