Isomorphism in high and low vesuvianite structure

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Vesuvianite is an orto-disilicate with difficult chemistry. It's general formula can be written as $X_{19}Y_{13}Z_{18}O_{68}T_{0-5}W_{10}$, where X is Ca and other large cations occupying 8-coordinate sites, Y are cations occupying 6 and 5-coordinate sites: Al, Mg, Fe, Ti etc., Z are Si occupying 4-coordinate sites, T is B in 3 and 4-coordinate sites, and W are monovalent and divalent anions: OH^-, F or O. Depending on ordering atoms in structure vesuvianite crystallizes in $P4/nnc$ (high) or $P4/n$ (low) space groups. Low vesuvianite occurs in metamorphic rocks formed at low temperatures (< 300º C compared to those containing high vesuvianite (400 - 800º C).

The collection of more than 50 vesuvianites were investigated by some methods so as electron - microprobe analysis, IR - spectroscopy, Mossbauer spectroscopy and others. We separated our samples of vesuvianites for space groups by its IR-spectra.

On the basis of mossbauer spectroscopy data the schemes of high vesuvianites isomorphism are specified. It is shown that the $Al + Fe^{2+} \leftrightarrow Fe^{3+} + Mg$ (1) and $(Mg + Fe^{2+} + Mn) + Ti^{4+} \leftrightarrow 2(Al + Fe^{3+})$ (2) schemes are realized simultaneously and supplement each other. The basic role is played by an equivalent scheme (1), and the scheme (2) has the subordinated value.

Based on IR - spectroscopy data of low vesuvianites we supposed the ordering of different cations in the new Y(3a) and Y(3b) positions. Ordering of Y cations in two nonequivalent Y(3) sites may proceed by two ways: 1) Mg, Ti and Al occupy one of these sites, and Al, Fe^{3+} - the second; 2) Mg and Al occupy one of Y(3) sites, and residuary Al and high valency cations occur in the second one. Then, for charge-balance observance the part of OH-groups have to be substituted by O(11).

B can replace H in O(10) position, which is accompanied by occurrence of new oxygen positions O(12) with triangular coordination around of atom of boron. B can also occupy $[O(11)_2\ O(7)_2]$ tetrahedra. Thus, the positions of two atoms of hydrogen connected with O(11) should be vacant because of very short distances H - B. IR – spectra of vesuvianites at 1300 - 1000 cm^{-1} have shown that in samples from rodingites the small quantity of B is triangular coordinated replacing H in the O(10) position (vibration bond 1270 cm^{-1}). In vesuvianites of skarns at decreasing of Al content B besides triangles begins to fill tetrahedra (vibration band 1110 cm^{-1}). The isomorphic scheme $B + (Mg, Fe)^{2+}$? 2H + Al is realized. B occurs in tetrahedra of high Al and Mg, practically Fe - free samples from Talnakh skarns which were exposed by rodingite process. There the realized scheme of isomorphism is $B + Mg \leftrightarrow 2H + Fe^{3+}$.

East-Asian Dust Sources and Long-Range Transport: Mineralogical and Isotopic (Sr and Nd) Constraints

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Eastern Asia is at present one of the main global sources of wind-blown mineral dust. While most of the dust is deposited near its sources, e.g. China, Japan, the western North Pacific Ocean, large amounts are transported long distances in the Westerlies. Dust events originating from Chinese and Mongolian deserts are regularly observed across the Pacific Ocean as far as the west coast of the US. In these locations, the Asian origin of the dust can generally be determined directly from satellite imaging or indirectly by air masses back-trajectory analysis.

It has been shown, however, that Asian dust is transported far beyond what can be reliably inferred from remote sensing or wind-field analyses. By comparing mineralogical and isotopic composition of mineral dust extracted from recent snow deposits with that of small particles (<5 µm) in the potential source areas (PSAs) of the northern hemisphere, we have shown, for instance, that Eastern Asia was the main source for dust deposited in Greenland [Bory et al., 2003]. Similarly, by combining such tracers with atmospheric dust transport model outputs, a dustfall of Asian provenance has recently been identified in the French Alps [Grousset et al., 2003].

Furthermore, the mineralogical and isotopic (Sr and Nd) characterization of East-Asian PSAs has shown that the main deserts of the region have distinct isotopic signatures. This enabled us to pinpoint the different Asian sources contributing to long range transport and to distinguish their seasonally-varying contributions as recorded in Greenland snow [Bory et al., 2003].

We present a review of these mineralogic- and isotopic-based findings together with new data from several Chinese PSAs, from Midway Island, and from North America, which provide additional clues for our understanding of long range transport of Asian dust, with hints of distinct atmospheric pathways across the Pacific

References

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