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# Crystal chemistry of the mixed-layer sequence talc–talc-smectite–smectite from submarine hydrothermal vents

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## ABSTRACT

Clay samples of hydrothermal origin from several oceanic spreading centers were studied using XRD, microprobe, infrared, and thermal analysis. They are talc, smectite, and mixed-layer talc-smectite (T-S) where the talc layers have several degrees of crystalline order. The smectite is trioctahedral in most cases, but there is also dioctahedral smectite both as mixed-layer and as a separate phase. All specimens contain $Fe^{3+}$, some of them in moderate amounts (up to 17% $Fe_2O_3$) distributed between the tetrahedral and octahedral sheets (maximum values: $^{IV}Fe = 0.32$, $^{VI}Fe = 0.68$, per $O_{10}[OH]_2$). Octahedral Fe abundance correlates with the presence of molecular water that is lost in a well-defined dehydration event above 200 °C. This water does not cause layer expansion and is interpreted to be present within the pseudo-hexagonal cavity, next to $Fe^{3+}$ ions that generate a local charge imbalance. The presence of octahedral $Fe^{3+}$ is accompanied by vacancies in the octahedral sheet to balance the excess positive charge. An infrared band at ~790 $cm^{-1}$ is assigned to OH bending in the group Fe-Mg-□-OH. Analysis of this band suggests a range of short-range Fe-□ distributions, from random to ordered. Our sequence talc, T-S, trioctahedral smectite is defined by an increasing Al for Si substitution in the tetrahedra and increasing crystal disorder. The presence of Fe also causes crystal defects. This mixed-layer series can be considered as a continuum generated by the combination of chemical and crystal defect variability. Kerolite was used to designate disordered, hydrated talc. We find that there is no clear line delimiting talc from kerolite as a single phase or in mixed-layer minerals and that it is better to use a descriptive term for the latter such as "disordered talc." Dioctahedral smectite is also a possible end-member of the mixed-layer sequence, which implies an Al + □ for Mg substitution in the octahedral sheet. If T-S consists of polar TOT layers, the existence of dioctahedral smectite in T-S raises the question of the actual composition of the octahedral sheets within polar TOT layers.

**Keywords:** Crystal chemistry, infrared spectroscopy, kerolite, talc, talc-smectite, thermal analysis, trioctahedral smectite, X-ray diffraction