

## FORMATION AND STABILITY OF MAGNESIUM HYDROCARBONATE MINERALS DURING SERPENTINIZATION AND WEATHERING OF SERPENTINITES.

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**Introduction:** Serpentinized peridotite is a major component of the ocean crust. Recent estimates place the percentage of serpentinized peridotite in slowly spread crust at near 20% [1]. This means that alteration of the serpentinized peridotite may play a much larger role than previously thought in determining the chemical composition of seawater and the budget of subducted material. However, an alteration process of serpentinite, not only in ocean but also on the surface of the earth, is still ambiguous even though some research fields such as mineralogy, petrology, geochemistry landslide engineering and plant ecology have great concerns about that.

On the other hand, magnesium (Mg) hydrocarbonate (MHC) minerals generally occur with ultra-basic igneous and metamorphic rocks such as serpentinites. Particular species of the minerals such as artinite without serpentine would be very unusual. Because such MHC minerals favorably form during serpentinization and weathering of serpentinites (major component of the ocean crust as mentioned above), the formation and stability of the minerals may be important to discuss the budget and flux of Mg and CO<sub>2</sub>.

In this context, this study examines the serpentinites with different degree of weathering to understand the formation and stability of MHC minerals.

**Samples and Methods:** The serpentinized rocks (dunite and harzburgite) with different degree of weathering have been collected from Mineoka of Chiba prefecture and Shikoku district, Japan. The samples were analyzed by optical microscopy, XRD, XRF, TG/DTA, observation using SEM and quantitative analysis using EPMA. The density and the equilibrium pH of each sample were also measured. The stability fields as function of temperature, pH, fugacity of CO<sub>2</sub>(g) and so on were calculated for artinite and hydromagnesite using geochemical code Tact and Act2 in The Geochemist's Workbench® 3.1 [2].

**Results and Discussion:** Hydrotalcite, pyroaurite, brugnatellite, artinite and hydromagnesite were found in the micro veins of the collected samples. Hydrotalcite and chrysotile or pyroaurite and chrysotile were observed to be parallel to each other. Hydrotalcite and pyroaurite have a fibrous or platy form and occur probably as pseudomorph of Al- and Fe-bearing serpentine, respectively. On the contrary, brugnatellite, artinite and hydromagnesite are euhedral and crystallized to fill the fractures. The brugnatellite and artinite are always accompanied with brucite without exception. The moldy hydromagnesite is found on the fibrous artinite (see Figure) or on the surface like cements. The occurrence of brugnatellite and artinite im-

ply that the minerals are formed by dissolution of brucite and precipitation from the solution containing the dissolved Mg and CO<sub>3</sub><sup>2-</sup>. From the calculated stability diagrams, the artinite is formed at higher pH than 9, low fugacity of CO<sub>2</sub>(g) and less than 40°C. The above condition is presumably achieved at near surface but unexposed to the atmosphere. The pH of solution precipitating artinite would be 10.2 if the solution is equilibrium with brucite dissolution. The hydromagnesite is stable at higher fugacity of CO<sub>2</sub>(g) than that of artinite, and the stability field extends to the fugacity of the atmospheric CO<sub>2</sub>. The condition occurring hydromagnesite is therefore available at surface exposing to atmosphere, and the hydromagnesite is formed due to the dissolution of artinite or other Mg-minerals such as brucite and serpentine at atmospheric condition.

All of the MHC minerals observed in this study are stable at higher pH than 9. The high pH values would be maintained during dissolution of brucite, deformation and dissolution of serpentine minerals after dissolving brucite. Thus, serpentinites maintaining high pH condition of pore water have high resistance to weathering. On the other hand, serpentinites containing no brucite, much olivine and pyroxene have lower resistance to weathering, which induce a development of soils, the formation of Fe- and Si- low crystalline materials from the serpentine, olivine and pyroxene, loss of Mg, and no carbonate during the weathering at neutral condition. Consequently, weathering of serpentinites and formation and stability of MHC minerals are mainly determined by mineralogy of host rock and degree of serpentinization.

**References:** [1] Cannat, M. et al. (1995) *Geology*, 23, 49-52. [2] Bethke C.M. (1998) *The Geochemist's Workbench Users Guide*. Univ. of Illinois, pp 184.

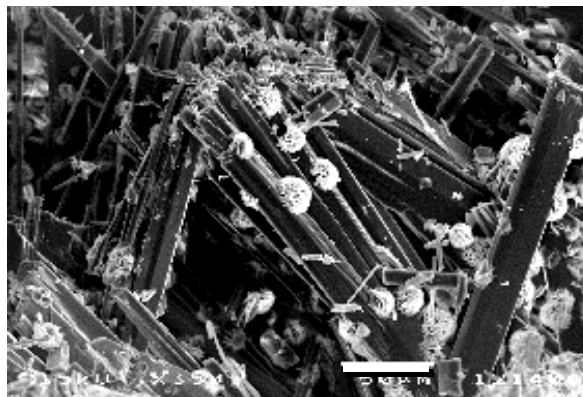


Figure SEM photograph of fibrous artinite and moldy hydromagnesite.