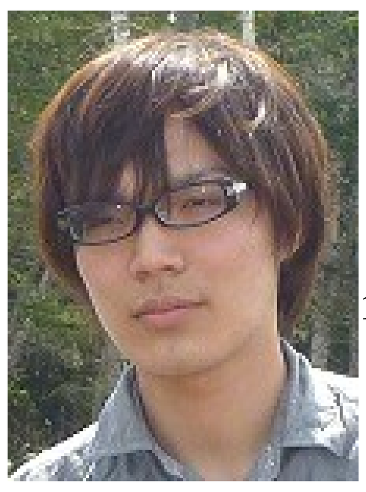


Natural analogue study for interaction between alkaline groundwater and bentonite at Mangatarem region in the Philippines

Y. Tsukada[1], K. Fujita[1], R. Nakabayashi[1], T. Sato[1], T. Yoneda[1], M.Yamakawa[2], N. Fujii[2], K Namiki[2], T. Kasama[3], R. Alexander[4], C. Arcilla[5], C. Pascua[6]
1.Hokkaido University, Japan, 2.RWMC, Japan, 3.Technical University of Denmark, Denmark, 4.Bedrock Geosciences, Switzerland, 5.University of the Philippines, Philippines, 6.Mariano Marcos State University, Philippines
Email: Tsukada.Yausmoto@gmail.com

Introduction

Background

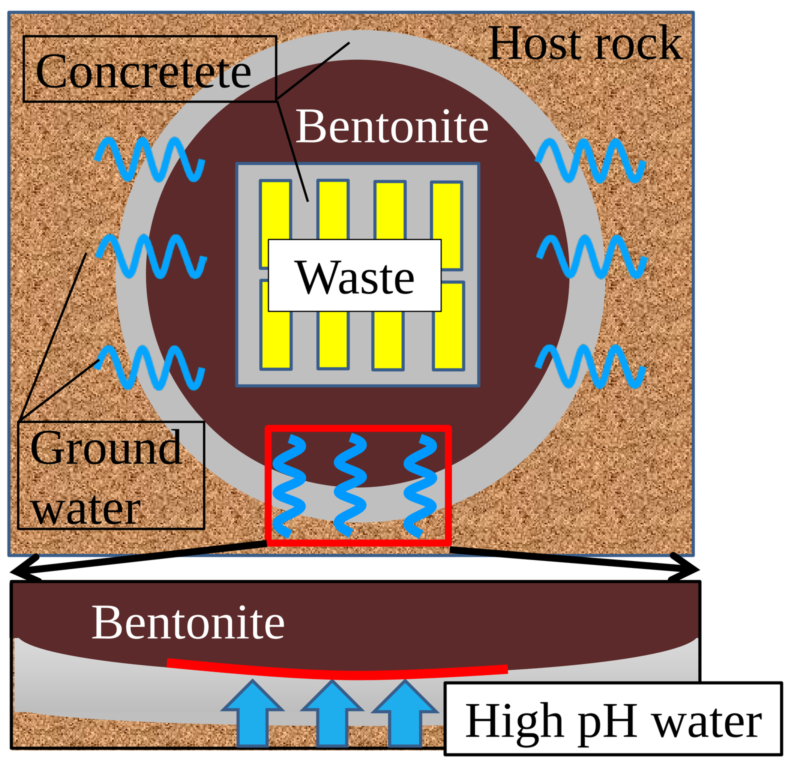
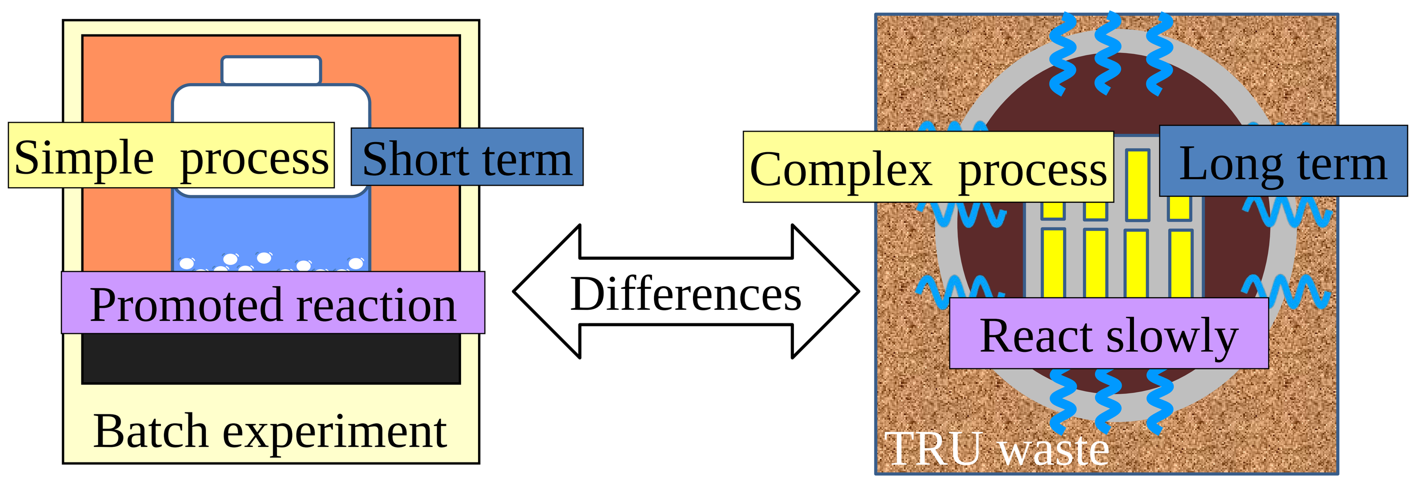


Fig. TRU waste repository design

Interaction between bentonite and high pH water would affect bentonite performance as a buffer material.

Differences between laboratory experiments and site conditions



Laboratory experiments not enough to assess safety performance.

Natural analogue study

Natural analogue studies at Mangatarem region

bentonite ⟷ Interaction ⟷ High pH water

Natural analogue studies on cement-bentonite interaction are relatively few, hence, this field study.

Serpentinization in Ophiolite complexes

High pH spring (Serpentinization)		Leachates in disposal site due to cement degradation
・High pH water ・Ca-rich ・Reducing environment	≒	・High pH groundwater ・Ca-rich ・Reducing environment
(e.g. Barnes et al, 1972)		

Objective

Clarify the alteration process of bentonite and its extent in geological time scale through contact with hyperalkaline solutions.

Geological background and Pass way of hyperalkaline fluid produced by lowtemperature serpentinization

Geological background

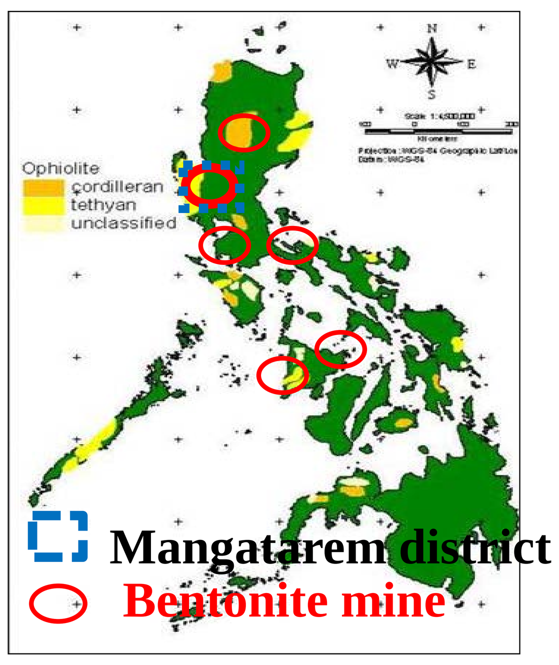
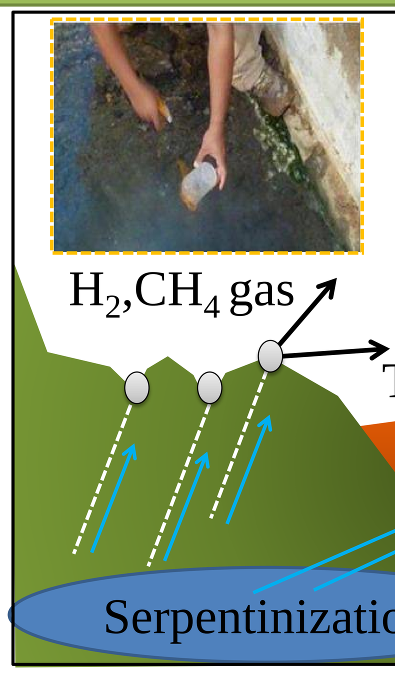


Fig. Distribution of bentonite mines and ophiolite complexes in Luzon island, Philippines.



Temp(℃)	34.2
pH	11.0
ORP(mV)	-410
Ca^{2+}(mg/L)	24.3
Mg^{2+}(mg/L)	<0.05

Table. Water quality data

Fig. Cross-section of Saile mine (Mangatarem district)

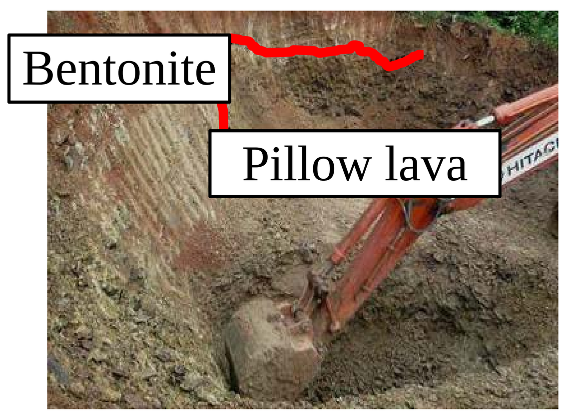


Fig. Photo of trench excavation

The contact area between the bentonite and the pillow lava in ophiolite was confirmed. Furthermore, a fault cutting through both the pillow lava and bentonite, is filled with two minerals.

Pass was of hyperalkaline fluid

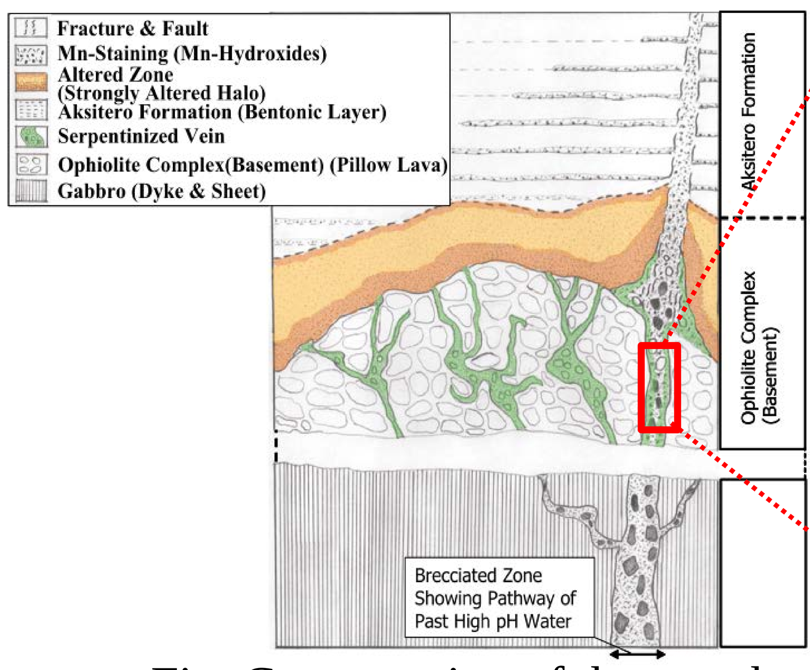


Fig. Cross section of the trench

Fig. Filling minerals

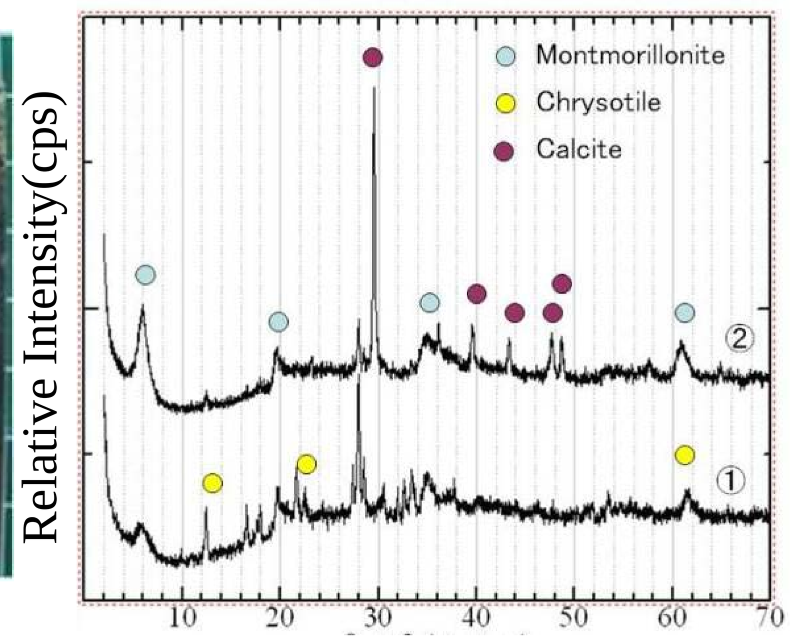


Fig. XRD patterns of the filling minerals

The fractures were filled with two minerals: abnormal chrysotile (low temperature type serpentine) and calcite. The same characteristic was generally observed in rocks formed by low temperature serpentinization.

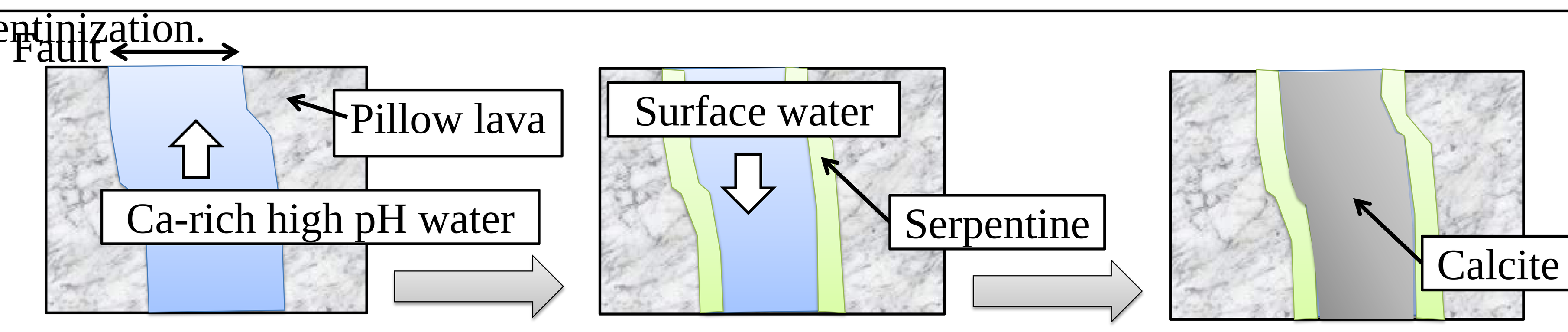


Fig. The sequence of mineral deposition during filling process in the fracture.

Mineralogy and Alteration process at the interface between bentonite and pillow lava

Interface between bentonite -pillow lava

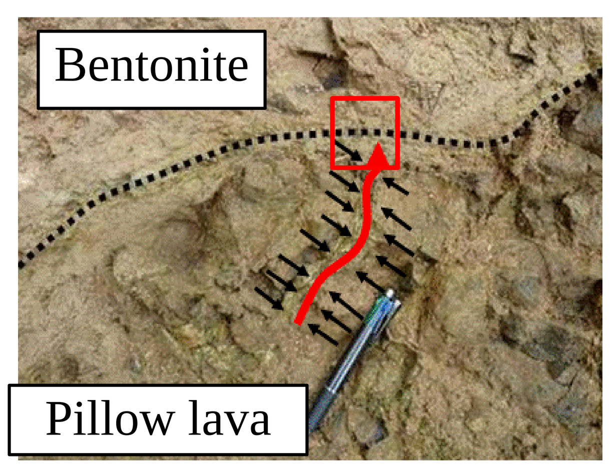


Fig. Contact area in mm scale

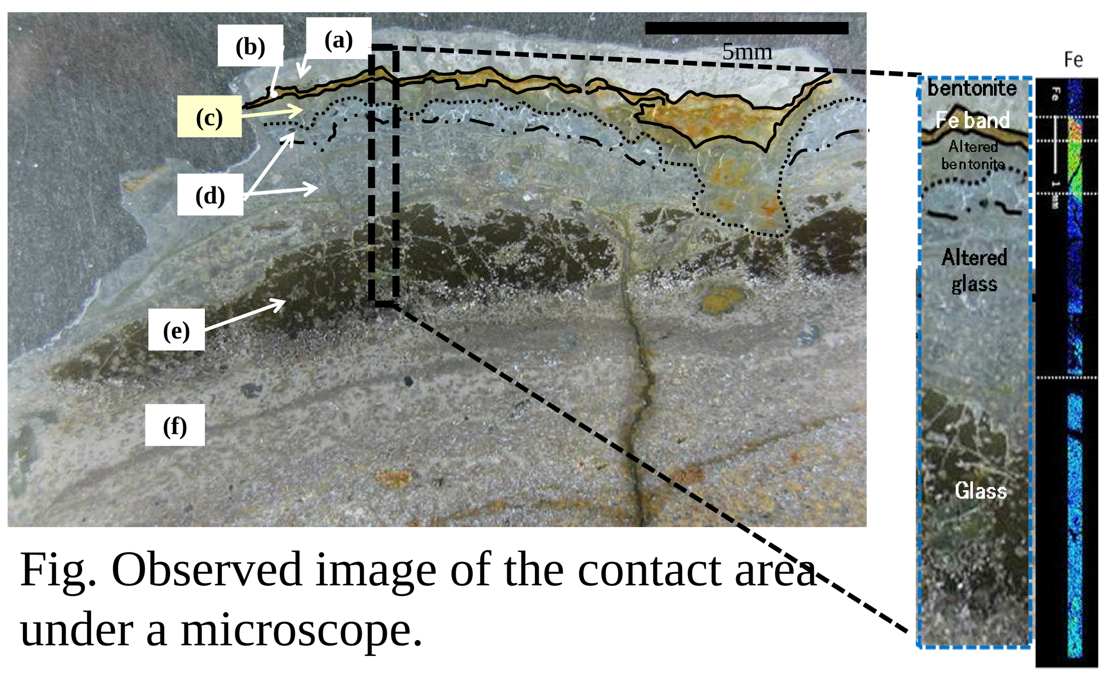


Fig. Observed image of the contact area under a microscope.

The boundary can be divided into the following 6 zones :
(a)Unaltered bentontie, (b) Concentrated Fe band, (c)Altered bentontie, (d)Altered glass, (e) Glass of pillow lava, and (f)Pillow lava

X-ray CT

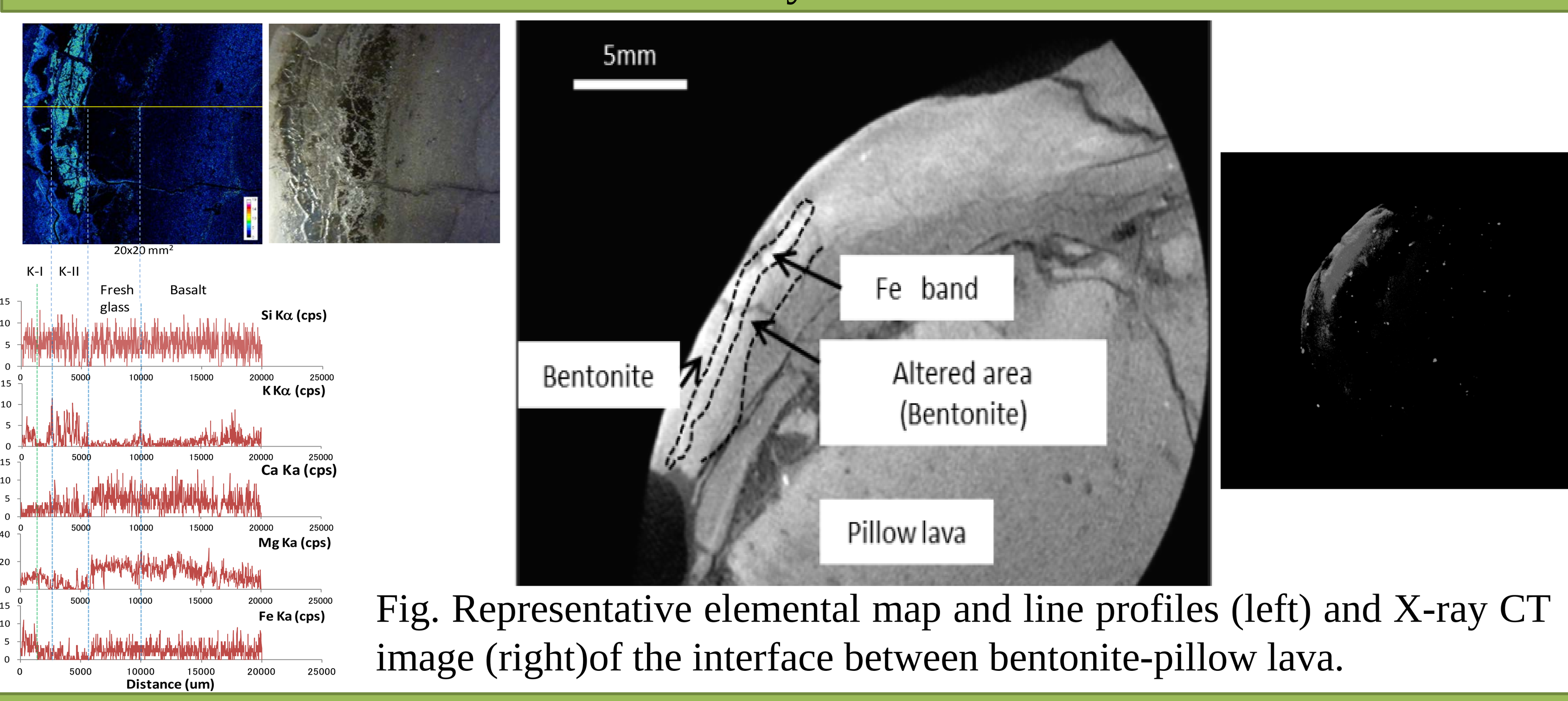


Fig. Representative elemental map and line profiles (left) and X-ray CT image (right)of the interface between bentonite-pillow lava.

Secondary (authigenic) minerals

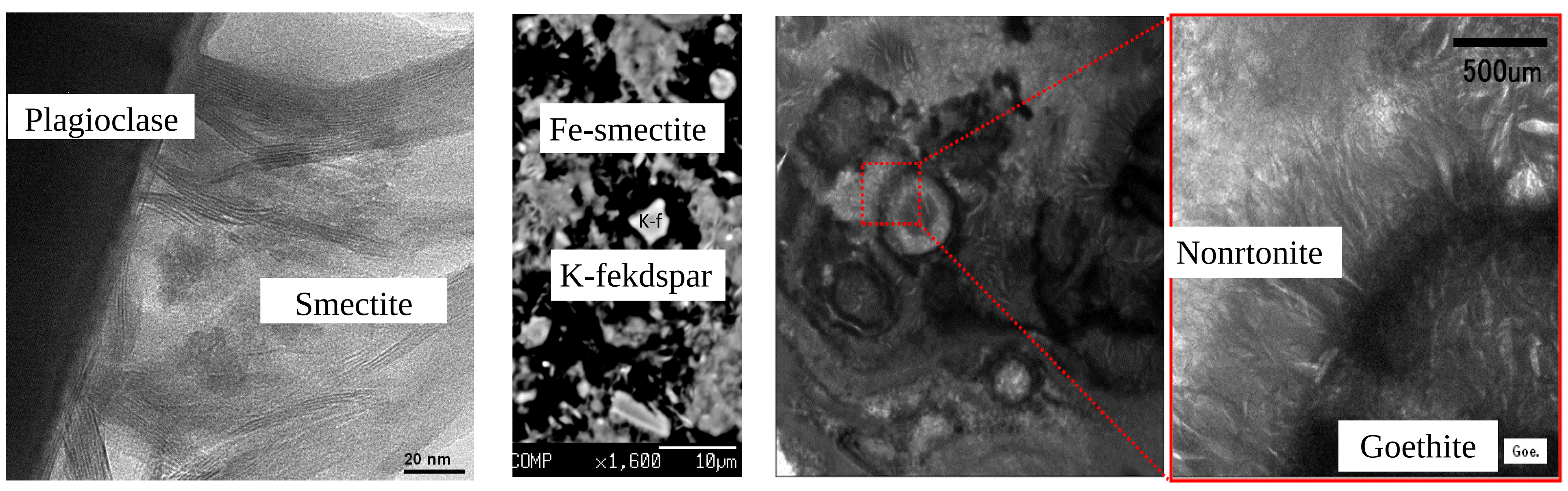


Fig. Photographs of the secondary (authgenetic) minerals: (a)TEM image of altered bentonite zone, (b) SEM image of the altered bentonite zone, and (c) TEM images of the concentrated Fe zones.

Alteration process at the interface between bentonite-pi

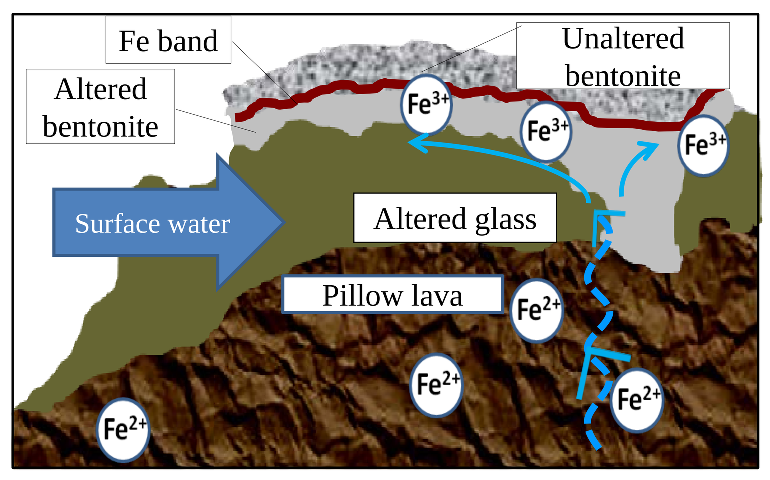
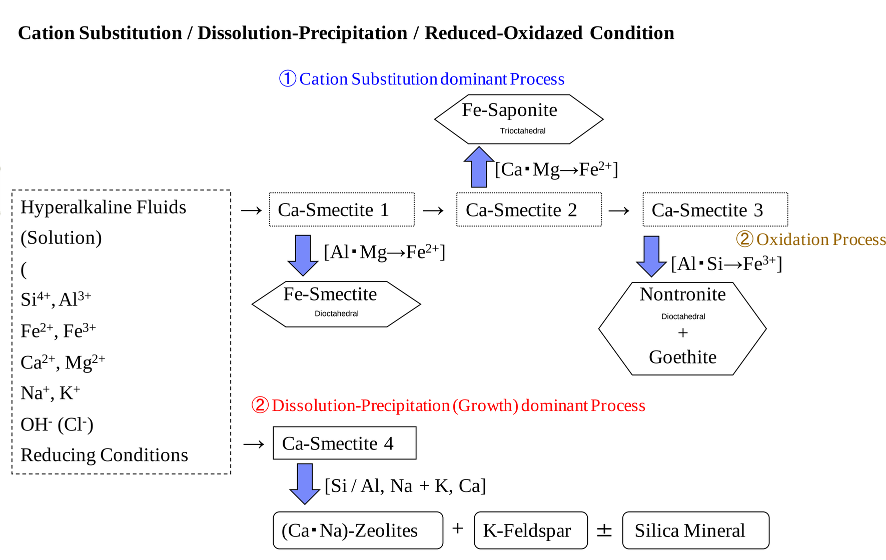


Fig. Alteration process at the interface



Secondary mineral formation may caused the clogging of fluid pathways.
→ The alteration at bentonite-lava interface was limited to zones 1-5 mm thick

Conclusion

The alkaline solutions converted the smectite in the bentonite to secondary minerals, as well as causing the clogging of fluid pathways with secondary mineral fillings. Consequently, the alteration of the bentonite through the contact with hyperalkaline solutions was limited to several millimeter-sized regions.

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