

**PETROLOGICAL STUDY ON EVALUATION OF ALKALI-SILICA REACTIVITY AND EXPANSION ANALYSIS OF ANDESITE**



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Key Words: andesite, reactivity, glassy andesite, pore solution, pH, ionic strength, petrographic evaluation, accelerated mortar bar test

**1. Introduction**

Andesite is a typical reactive aggregate and is common in Japan. One fourth of crushed aggregate is andesite [1]. However, the discussion on the difference in reactivity of andesite in different alkali conditions has been limited. Alkali-silica reactivity of andesite is complex because of its various mineral compositions related to alkali-silica reaction, ASR.

Andesite and other volcanic rocks have been examined extensively in Japan but mainly by chemical method and mortar bar accelerating test in which alkali content of cement is controlled as 1.2 % by mass and cure at 40 °C according to JIS (Japanese Industrial Standards) A 1146. However, because of the change in alumina source from clay to coal ash from middle 80's, alkali level of Japanese Portland cement was limited less than 0.65% by mass. This situation was quite

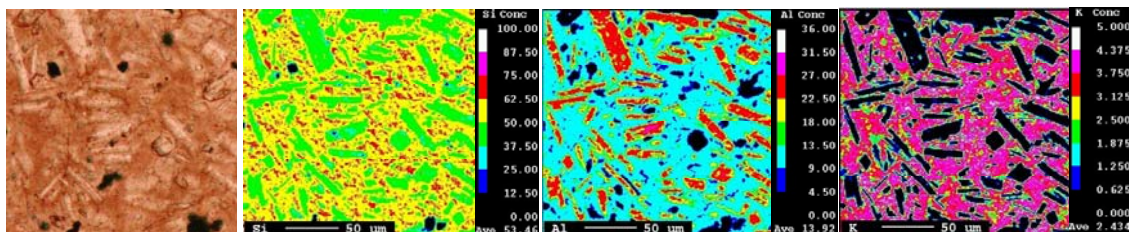
effective to control ASR caused by the high initial alkali content. Therefore, it is thought that remained risks of ASR in Japan are alkali release from aggregate and alkali supplying from deicing salt or seawater [2].

Though a number of papers related to ASR have been reported, most of them missed the petrographic evaluation of aggregate. Therefore, sometimes different tests give different results. It is important to clarify the alkali-silica reactivity of aggregate based on petrographic evaluation [3].

In this paper, the authors investigate the alkali-silica reactivity of andesite in various alkali supplying conditions based on petrographic evaluation.

**2. Varieties of petrographic features and alkali-silica reactivity of andesite**

Typical image of optical microscope and EPMA mapping of glassy andesite (An (M)) is shown in Fig. 1. Scatter diagram of



(a) Optical (b) Si (c) Al (d) K

Fig.1 Optical microscope and EPMA mapping (An (M))

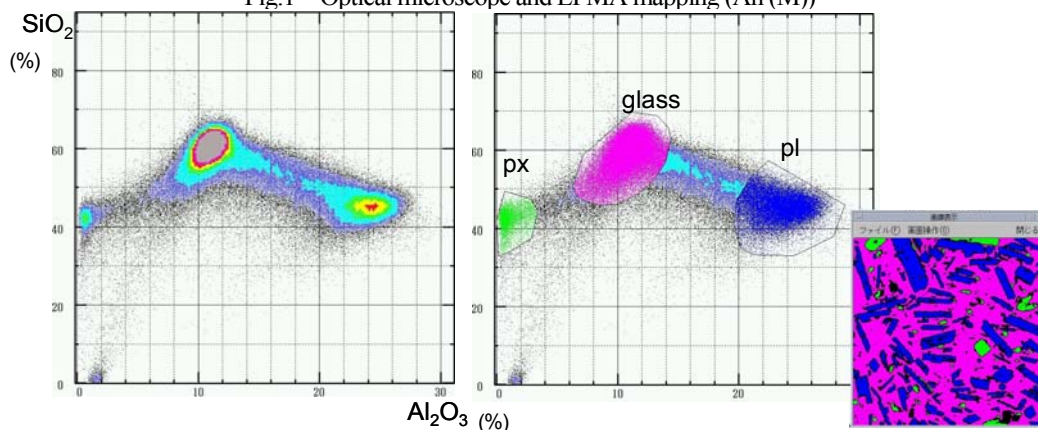


Fig.2 Scatter diagram of SiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> (An (M))

silica and alumina for measurement points are useful to identify the phases such as plagioclase and pyroxene.

In An (M), clear phenocrysts and matrix of glass phase are observed without alteration. Potassium locates only in matrix glass because it is not contained in phenocrysts such as plagioclase and pyroxene and it remained in liquid phase that was consolidated as glass. Silica mineral does not exist in An (M).

In Fig. 3, the texture is more complex because of alteration in An (A). The areas of high potassium concentration seem to be altered glass. Figure 3 shows the existence of silica mineral. This silica mineral is identified as cristobalite by XRD.

Fig. 4 shows the results by chemical test. The judgment line whether reactive or innocuous is Rc:Sc = 1:1. Except three points, every data is plotted in reactive area. Among innocuous aggregates, Ba (E) is basalt, Di (D) is diolite, and An (P) is andesite but altered severely and reactive silica minerals are assumed to be changed to less reactive quartz.

Another characteristic point is only two samples, An (M) and An (N) have relatively low Rc. An (M) and An (N) are unique for its mineral composition. They have no silica minerals but contain glass. In chemical test, glass and reactive silica minerals such as cristobalite and trydimite shows high reactivity.

### 3. Expansion behavior of mortar in saturated NaCl solution

Fig. 5 shows the expansion behavior of mortar in saturated NaCl solution. Mortar containing reactive silica minerals shows large expansion. Expansion is correlated to their contents. The most striking feature is mortar used An(M) and An(N), glassy andesite without reactive silica minerals shows non-expansive while it shows expansive in other tests. Thus, volcanic glass is judged as “non-reactive” in saturated NaCl solution. This paper clarified the reason for this phenomenon as the interaction between pore solution composition and dissolution behavior of reactive phase. Solubility of glass is strongly dependent on pH of pore solution. In saturated NaCl solution, dissolution of glass is extremely low whereas cristobalite shows high solubility.

These results indicate one possibility that limited risk of ASR expansion for glassy andesite in specific environment where alkalis are supplied from environments such as deicing salts when no silica minerals are included in the andesite and initial alkali content is controlled under certain value.

### 4. Conclusion

In this study, the alkali-silica reactivity of andesite was evaluated by various accelerating tests based on petrographic features. Reactivity of andesite depends on its dissolution behavior and pore solution composition. The results indicated one possibility that glassy andesite is innocuous even in specific environment where alkalis are supplied from environments such as deicing salt and sea water in case of low initial alkali content. This study concluded that the petrographic evaluation of aggregate is important to understand the ASR-related problems.

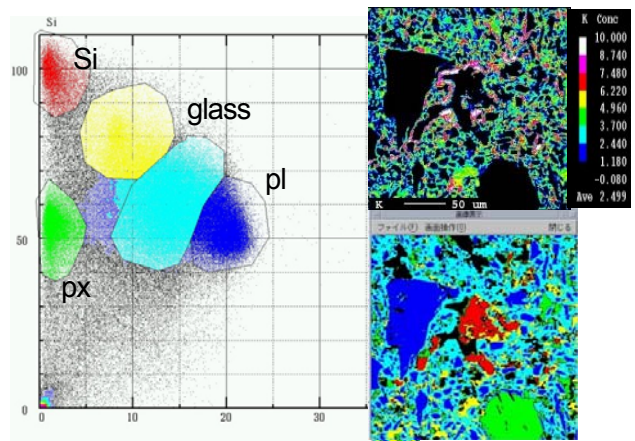


Fig. 3 Scatter diagram of SiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> (An (A))

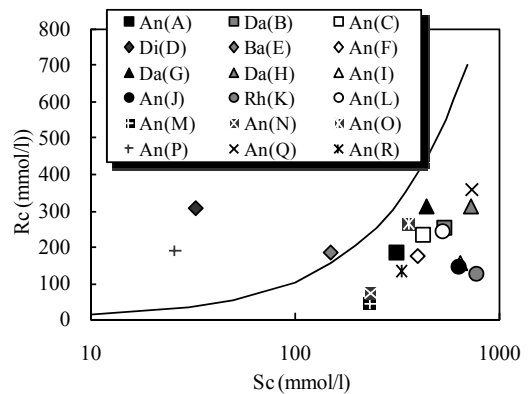


Fig. 4 Chemical test

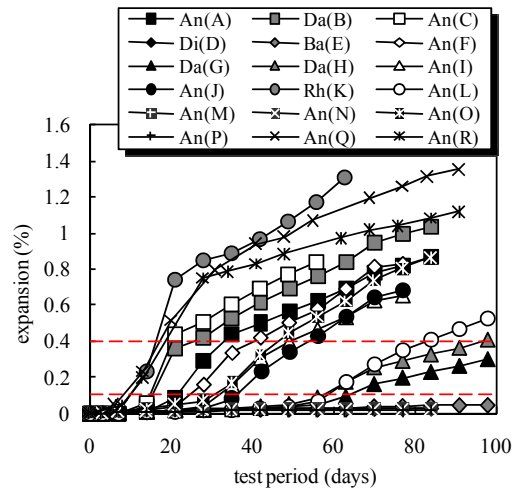


Fig. 5 Expansion behavior of mortar in saturated NaCl solution

### References

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