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## The mineralogical and petrological factors in the alkali-silica reactions in concrete

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Reactive silicas which can cause Alkali-Silica Reactions (ASR) are opal, SiO<sub>2</sub>-rich volcanic glass, chalcedony (or fibrous quartz) and tridymite. Opal is a hydrous cryptocrystalline or colloidal form of silica (SiO<sub>2</sub>.nH<sub>2</sub>O) with a water content of around 6% to 10%. Silica-rich volcanic glass is a component of many young volcanic rocks. Chalcedony is a compact variety of silica composed of minute (crypto- or micro-crystalline) crystals of quartz (SiO<sub>2</sub>) enclosing submicroscopic pores. Tridymite is a rare hexagonal high temperature polymorph of quartz with a S.G. of 2.28.

Opaline silica and silica-rich volcanic glass are regarded as the most reactive. Chalcedony, tridymite and some forms of crypto- and microcrystalline quartz occurring in acidic volcanics, chert and flint are regarded as of intermediate reactivity. Strained macrocrystalline quartz can cause ASR but only under certain conditions.

A factor which may influence the reactivity of particular aggregate is the proportion of reactive materials that is present in the aggregates. For a very reactive opaline silica the worst expansion may occur when it is found in the order of 2% to 5% (in the coarse aggregate), that is the pessimum. The pessimum for silica-rich volcanic glass is unknown. In the case of the strained macro-crystalline quartz, the pessimum being 100% that is quartzite containing wholly of strained quartz. The pessimum for the intermediate reactive silica is not known, but could well be higher than that of the opaline silica and definitely lower than that of strained quartz.

A multitude of rocks can cause ASR and there are many others which will not. Common rock types often used for aggregates can be grouped into: (i) Inherently reactive (ii) Potentially reactive if pessimum amounts of reactive silicas are present and (iii) Innocuous unless impregnated by secondary reactive silica minerals. Fine aggregates can also cause ASR to produce distress in concrete.

A sweeping ban on all volcanic aggregates for use in concrete may give a false sense of confidence for the control of ASR in Singapore. Banning of alkali-rich cement/clinker is a better way of controlling ASR as well as other alkali-aggregate reactions.