Selection of stone investigations

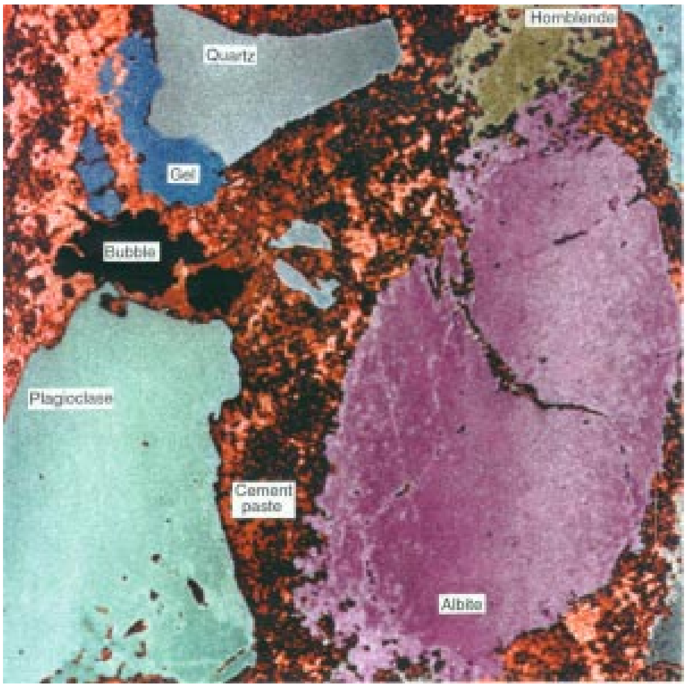
The role or the aggregate grain composition at the interface is demonstrated in Figure a. A different type of reaction rim is observed around the various minerals present in this image.

- The albite (sodium-rich feldspar, pink colored) grain boundary is severely eroded, indicating extensive reaction.

- There is some evidence of a transition zone for plagioclase (light green colored), but it is much less developed than in albite.

- No reaction rim around the quartz (gray colored). The gel phase (blue colored) may be the product of a reaction with the unidentified phase to the left.

- The hornblende (iron-rich amphibole, ochre colored) grain is almost fully reacted.

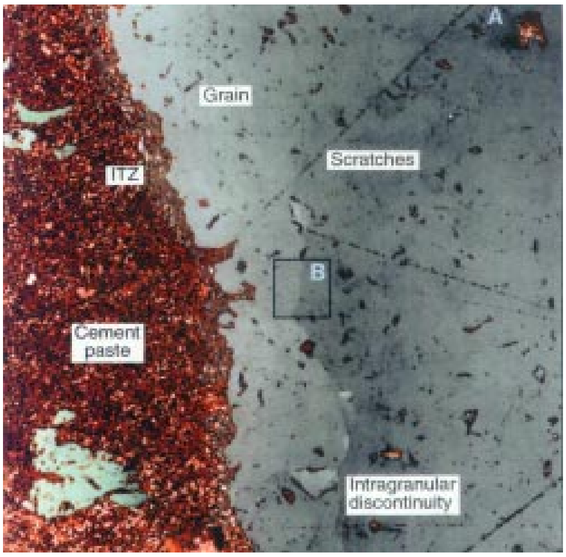


Courtesy of Dr. Manika Prasad

Fig. a: Granitic aggregates without silica fume
Frequency: 400 MHz
Size: 1000µm

Selection of stone investigations

The sample with andesitic grain aggregates similary shows feldspar grains (figure c) with severely eroded grain boundaries, whereas a quartz grain in the same sample (Fig b) has a sharp grain-matrix boundary with a minor reaction rim.



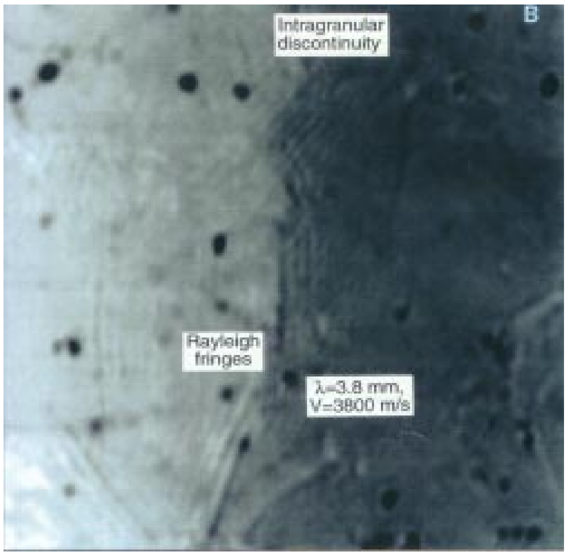
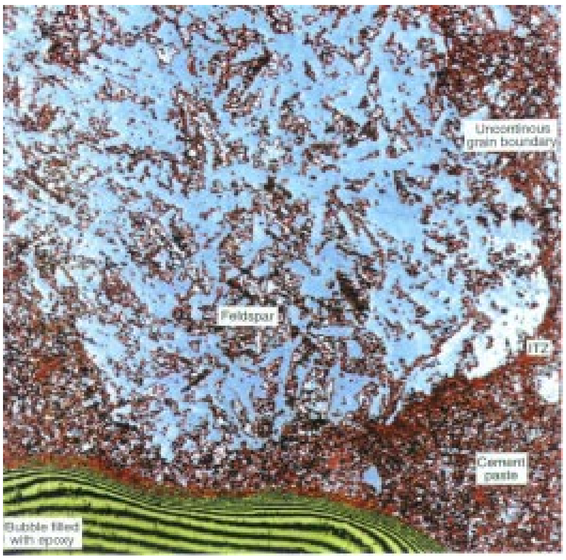


Fig. b: Frequency: 1000 MHz, slightly defocussed
Size: 1000 x 1000μm (zoomed to 100 x 100 mm)



Courtesy of Dr. Manika Prasad

Fig. c: Andesitic aggregates without silica fume
Frequency: 1000 MHz
Size: 1000x1000μm

These results suggest that the simple classifications of aggregate type now used in the concrete industry, e.g., granitic, limestone, etc. may not be adequate to predict the ultimate strength of the concrete.

acoustic microscopy

Selection of stone investigations

Air bubbles are a typical feature of cement mortar. A long standing question in concrete technology is the nature of the bubble/matrix interface.

Figure 1 is an SAM image showing a layer of cement matrix between two granitic sand grains. distinct zones of similar gray shades are seen in the cement matrix which follow grain boundaries and can be correlated to the concept of ITZ.

The thin bright layer along the grain boundaries and dispersed in the matrix could represent the crystalline phase. Continuing into the matrix, there is another layer of similar impedance (gray shaded) which could correspond to the gel phase. The length scale size of this zone, on the order of 50 µm, is also consistent.

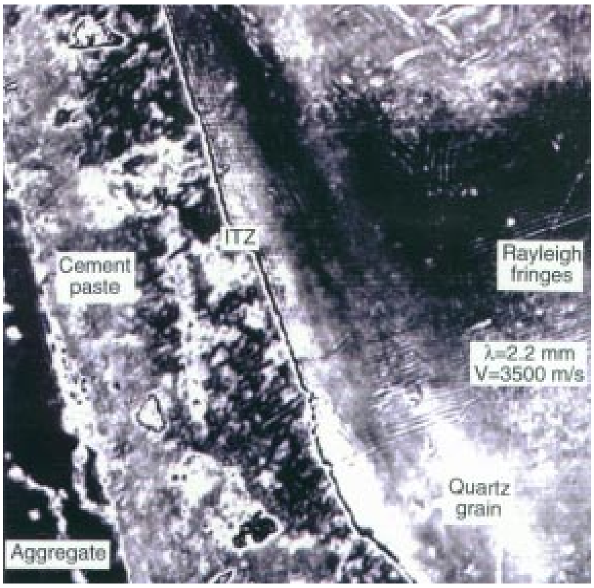


Fig. 1: Granitic aggregates without silica fume
Frequency: 800 MHz
Size: 312 x 312 µm

Interference fringes at grain and at sub-grain boundaries allows us to identify the right-hand side grain as quartz. They have a spacing of 2.2 µm giving a Rayleigh wave velocity, VR = 3500m/s (VR for quartz = 3410 m/s. Intragranular variation in elastic properties give rise to gray shades within the grain.

The dark line at the interface between cement matrix and quartz grain is due to a lack of bond. This discontinuity produces Rayleigh interference fringes parallel to the grain boundary

acoustic microscopy

Selection of stone investigations

A currently much debated problem is recent concrete failure due to expansive forces, possibly because of ettringite (C-A-S-H) formation. It occurs in distinct needle shaped crystals and is identified by its crystal structure through x-ray diffraction.

Ettringite formation around a bubble is shown in figure 2. The elongated structures appear as needle-shaped crystals under light microscope.

In figure 1, the boundary is discontinuous, there are crystal growths in the bubbles and numerous cracks around the bubbles.

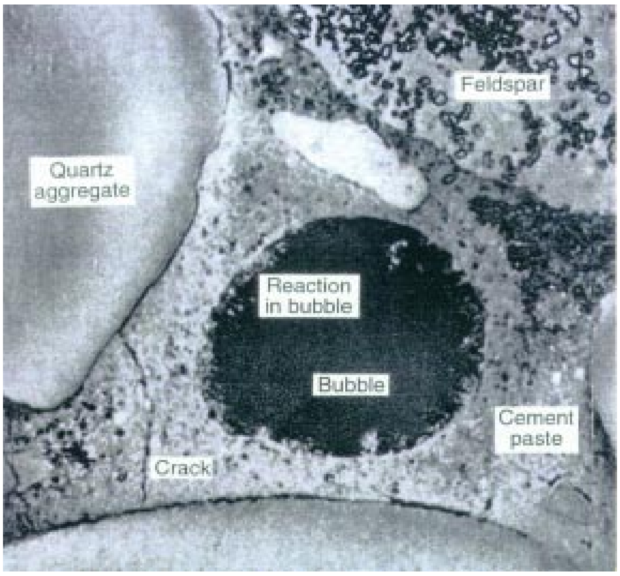


Fig. 1: Damaged concrete from precasting plant
Frequency: 400 MHz
Size: 1000 x 1000 µm

Courtesy of Dr. Manika Prasad

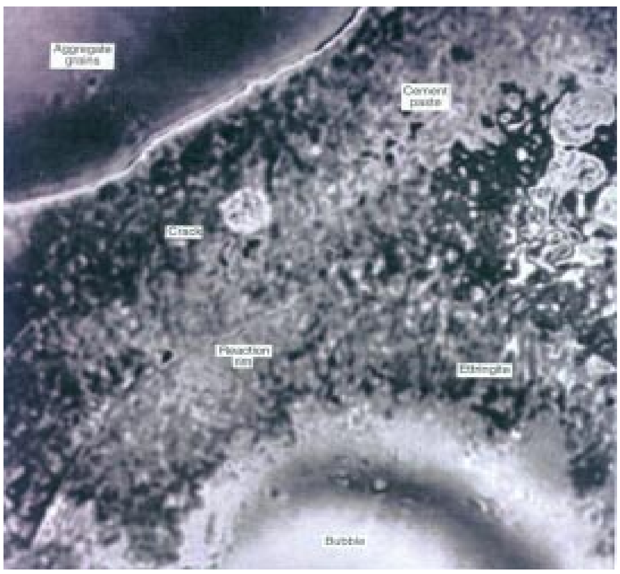


Fig. 2: Damaged concrete from precasting plant
Frequency: 1000 MHz
Size: 200 x 200 µm