Simultaneous measurement of ultrasonic velocity and attenuation loss: A new analyzing algorithm in frequency domain

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Background

A new analysing algorithm is developed for ultrasonic velocity measurement in order to eliminate the effect of bond, which enhances ultrasonic pulse transmission between sample and buffer rod. As bond has a finite thickness of a few micron meters, multiple reverberations at both end of bond have been the major source of error in ultrasonic travel time.

Procedures

The procedure of the present analysis is as follows: (1) The first and second pulses from sample are measured by using digitised oscilloscope. (2) Fourier transformation is applied for each pulse separately. The phase difference corresponds to time difference of the two pulses, or travel time of sound wave in sample. (3) The bond effect correction is applied for quotient between the Fourier coefficients of those two pulses. Acoustic properties of bond agent were measured separately by using reflectivity measurement. (4) The optimised travel time is determined by adjusting bond thickness and attenuation loss in sample. In this way, we can determine acoustic velocity and attenuation loss simultaneously.

Results and Discussion

The analytical algorithm is examined by a test measurement: Sample is ordinary glass plate of 1.23mm thickness; bond agent is SWC couplant (Panametorics Co.); transducer is for 20MHz shear wave. From the reflectivity measurement, acoustic properties of SWC couplant was fixed at Vs=1100m/s and Q=5 for 20 MHz shear wave. The thickness of bond was between 5 and 6 micrometers. The resulted travel time of sample is 728.8(7) nsec and Q~500. The Q value obtained in this analysis is consistent with literature data for soda glass. In the present measured data, simple pulse echo overlap is optimized at around 724 nsec. Thus the new algorithm succeeds to eliminate the bond effect as much as ~5 nsec. Although the reproducibility of travel time is ~0.1 % at the present, effort continues to improve it at least with one order of magnitude.

Long-term redox front formation: Influence of biogenic activity on matrix diffusion

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Redox fronts inevitably form around groundwater conducting fractures and influence elemental migration, but long-term microbial activity as a mechanism for redox front formation and nuclide migration and/or fixation combined with the matrix diffusion has received relatively little attention. In this paper, we describe a biogenically-mediated redox front for the last ca. 10^5 years along the groundwater-conducting fracture in a Tertiary tuffaceous sedimentary sequence with bands of highly concentrated major elements and various trace elements including REEs. These features have been studied in order to characterize the long-term barrier function that can rely on the geological environment around the waste repository.

In the investigations, the redox band formed along the fracture has been analyzed by XRF and ICP-MS for major and trace elements to understand the elemental profile from the fracture to the rock matrix. Also, direct examinations with EPMA, SEM-EDS and incubation experiment have been carried out to characterize the microscopic geochemical nature, as well as the effect of microbial activity on the subsurface redox front formation.

The results show that Fe, Mn, Si and rare earth elements are concentrated at the redox front even though there is little oxidation of the rock matrix. Detailed SEM observation revealed that fossilized pellet encrusting a microbial colony with iron oxidizing bacteria in the matrix micro porosity. In places microbial mats with bacterial cells were also identified. SEM-EDS analysis of the microbial mats showed that they are composed of amorphous granules made exclusively of Fe and Si. Incubation experiment suggests that *Leptothrix* type iron oxide microbe still has an activity to form iron oxide at the front. These findings suggest that microbial activity obviously can generate both continuous redox reactions and substantial elemental accumulation under low temperature conditions during 'matrix diffusion'. The observations made in this study have implications as analogues for understanding the long-term redox front formation combined with matrix diffusion for the various kinds of toxic nuclide retardation.