Occurrence of non-mineral inorganics in macerals of low-rank coals from Australia, New Zealand, Indonesia and Thailand

Z. Li, C. R. Ward, L. W. Gurba

School of Biological, Earth and Environmental Sciences. University of New South Wales, Sydney, 2052, Australia

Electron microprobe study of individual macerals in low-rank coals of Permian to Tertiary age from Australia, New Zealand, Indonesia and Thailand has shown that significant proportions of inorganic elements are consistently found in otherwise “clean” organic components, especially the vitrinite macerals, without any visible minerals or mineral inclusions being present. Typically the vitrinites of these coals contain up to around 0.5% Al, 1.5% Ca, 0.1% Mg, 0.7% Fe and 0.2% Ti. The Al occurs without significant proportions of Si, and hence does not represent sub-micron clay minerals within the maceral components. Inertinite macerals in the coals, such as fusinite, typically contain lesser proportions of these elements, and may even have no significant concentrations at all.

Detailed mapping of the concentration of such elements in the macerals of several low-rank coals (Li et al., 2007) shows that a majority of the Al, Ca and Fe are intimately distributed throughout the macerals, and thus probably occur as non-mineral inorganics rather than discrete mineral particles. The distribution of these elements is very similar to that of the organic S in the same macerals, particularly the telocollinite and fusinite, of the same coal samples. Where comparison has been attempted, the proportion of Ca indicated from probe analysis in the macerals, especially in the vitrinites, is very close to the proportion of mobile Ca indicated from selective leaching of the same samples. All this suggests that the elements occur as an inherent part of the organic structure in the macerals concerned, possibly as a combination of exchangeable ions, carboxylates, chelates and other organometallic compounds; they may also be held by physical absorption and adsorption mechanisms.

Although they may be retained in some circumstances (e.g. Ward et al., 2007), the non-minerals inorganic elements seem to disappear in equivalent higher rank bituminous coals (above 75% carbon in vitrinite). This probably reflects expulsion from the maceral structures during the progressive aromatization associated with rank advance by processes such as dehydration, decarboxylation, dehydroxylation, and condensation. In contrast to the occurrence of such elements as separate mineral phases in the coal, these non-mineral inorganics are intimately distributed throughout the organic matter, and connected with the macerals at a molecular scale. They are thus able to interact more readily during coal combustion and gasification processes. Whilst small amounts of Na, K and Ca in the macerals may act as catalysts in utilisation processes, excessive amounts of such elements occurring in non-mineral form may also cause undesirable fouling and slagging problems.

References: