DETERMINATION OF RANK IN NEW ZEALAND SOURCE ROCKS BY HIGH RESOLUTION NMR SPECTROSCOPY

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Abstract

Nuclear Magnetic Resonance (NMR) spectroscopy provides a non-destructive technique for measuring the chemical properties of organic matter. When first used to study maturation in source rocks over 10 years ago, 13C NMR could only measure the aromatic and aliphatic structural groups in kerogen. Now with further refinement of technique, oxygen-substituted groups on aromatic rings and carboxylic groups can also be qualitatively measured.

We have examined over 90 coal and shale samples of various ranks from mines, outcrops and wells in New Zealand. All parameters measured by vitrinite reflectance, rock-eval and NMR show a high degree of correlation to increasing rank. However, between serial plies or samples known to have the same rank, all of these parameters except oxygen-substitution, as determined by NMR, show a certain degree of unexplained scatter. This is probably due to variation in the chemical composition and hydrogen content of the vitrinite.

Our findings suggest the oxygen-substitution parameter is invariant to chemical variations in type III kerogens of the same rank. This parameter, which measures the loss of oxygen from aromatic carbon, is a site specific reaction dependent on temperature. Thus, it is free from the many variables that plague other maturation indices and prevent accurate determination of rank.

Although NMR equipment is expensive, the chemical information obtained from small samples of potential source rocks make it a valuable tool for petroleum geochemistry. However, to become widely used, NMR methods and hardware must become standardised.

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