

EGU21-522

<https://doi.org/10.5194/egusphere-egu21-522>

EGU General Assembly 2021

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High-Resolution Chronostratigraphy for Sedimentary Rocks using Rock Magnetism

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Rock magnetism can be used to identify orbitally-forced global climate cycles in sedimentary rock sequences. The identification of Milankovitch cycles with nominal periods of 20, 40, 100 and 400 ka can be used to construct a high-resolution chronostratigraphy for a rock sequence that can have a variety of important geologic applications. Several examples will be presented. The rock magnetic cyclostratigraphy of Eocene marine, deltaic mudstones and marls of the Arguis Formation illustrates how rock magnetism can be used to determine the deformation rates of a salt tectonics growth fold in the Pyrenees. The duration of the Ediacaran Shuram carbon-isotope excursion was determined to be 8-9 Ma from rock magnetic cyclostratigraphy studies of marine rocks from Death Valley, California (Rainstorm member of the Johnnie Formation), southern Australia (Wonoka Formation), and in central and southern China (Doushantuo Formation). Further cyclostratigraphic study of the Rainstorm member in the Desert Range, Nevada, allowed the construction of a high-resolution magnetostratigraphy by combining and calibrating magnetostratigraphic results from Death Valley and Nevada to reveal a high reversal rate of 12.7 reversals/Ma in the Ediacaran. More detailed study of the Doushantuo Formation at Huangliaba, China indicated that even though its ferromagnetic minerals were predominately secondary pyrrhotite, magnetic susceptibility measurements could still detect a depositional, orbitally-forced cyclostratigraphy carried by paramagnetic minerals. Finally, the Carboniferous Mauch Chunk Formation red beds from Pottsville, Pennsylvania yielded a magnetic susceptibility cyclostratigraphy in terrestrial, fluvial sediments despite their discontinuous sedimentation. This study showed that both portable susceptibility meter measurements and lab-based measurement of rock samples could discern the same period cycles. Detailed low and high temperature magnetic susceptibility measurements indicate that the ferromagnetic mineral hematite, rather than paramagnetic clays, is the predominant carrier of the orbitally-forced global climate signal. All these studies show the power of rock magnetism for constructing a high-resolution chronostratigraphy for sedimentary rock sequences.