2011 CSPG CSEG CWLS Convention

Magnetostratigraphy Dating and Correlation of the Lower Doig and Upper Montney Formations (Lower Triassic), Northeastern British Columbia, Western Canada

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Abstract

Accurate correlation within non-fossiliferous, fine-grained clastic successions such as the upper Montney and lower Doig formations is commonly problematic. Wireline log correlations are subjective and unambiguously synchronous marker horizons are not common. A pilot study was initiated to evaluate the potential of applying paleomagnetic correlation techniques to the study interval. A total of 129 samples from six well cores in northeastern British Columbia were analyzed. Two of the studied wells (09-29-79-14W6 and 12-35-79-17W6) exhibit normal and reverse polarities. A correlation of the geomagnetic polarity from this study matches a known portion of the Triassic geomagnetic polarity time scale (GPTS) at 245 Ma. Preliminary results suggest that the lowermost Doig phosphate zone may have identical paleomagnetic characteristics across the Montney and Doig boundary in different areas. This boundary is a coplanar *Trypanites – Glossifungites* demarcated discontinuity surface in all wells analyzed in this study and is herein interpreted to be a regionally correlatable surface.

Introduction

The Triassic Montney and Lower Doig formations comprise a primary focus of tight gas reservoir exploration in western Canada. The succession consists of very fine-grained sandstone, siltstone and mudstone. These units have previously been correlated primarily using conventional geophysical well-logs. The present study in northeastern part of British Columbia (Fig.1) employed paleomagnetic technique to constrain and augment correlations within the upper Montney and lower Doig formations. Magnetostratigraphic data was used to obtain the polarity record of the geomagnetic field in order to provide geochronological constrains and to augment local and regional correlations.

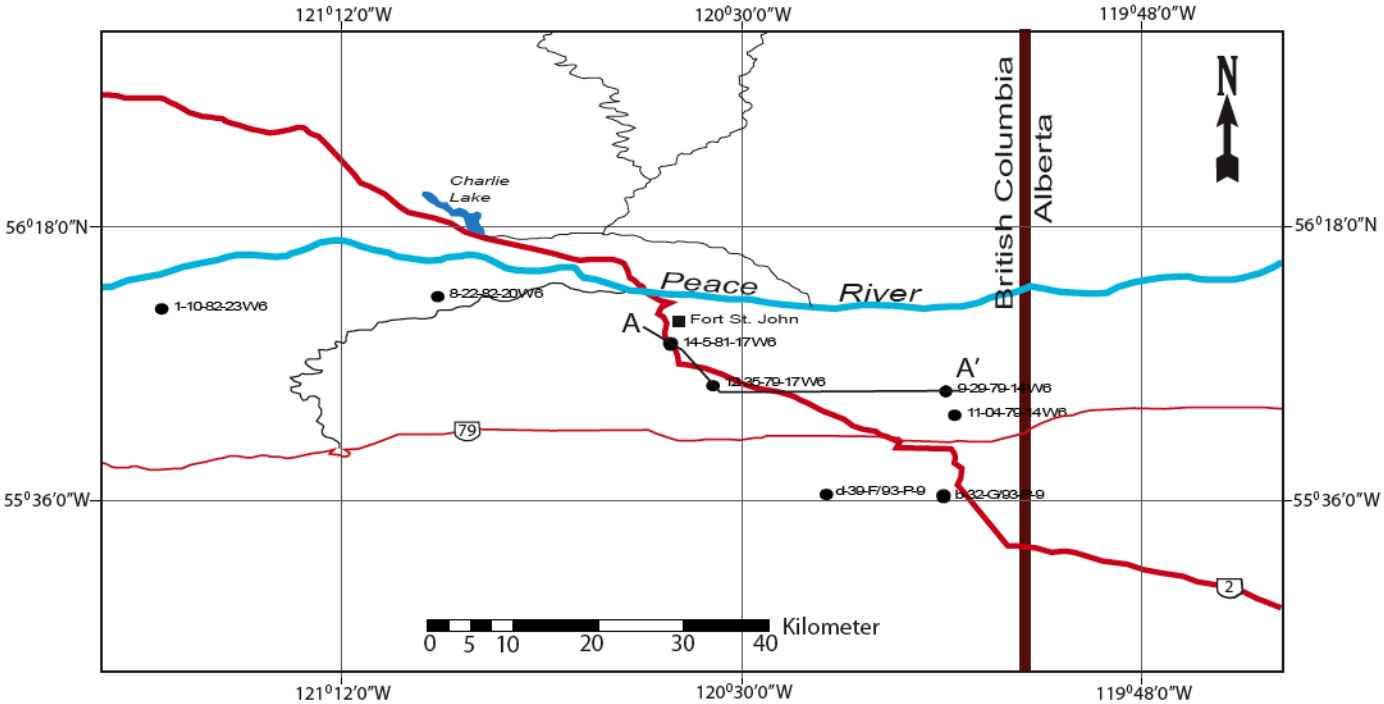

Figure 1: Map showing locations where paleomagnetic data were collected, northeastern British Columbia

Laboratory Methods

Oriented samples from six drill cores from the upper Montney and Lower Doig formations were used for this paleomagnetic pilot study. After transport to the University of Alberta, the samples were cut into square samples 0.8 cm to 2.2 cm long for analysis.

Magnetic measurements were performed in a magnetically shielded room of the paleomagnetic laboratory in the Department of Physics, University of Alberta. Remnant magnetization measurements were carried out using a 2G Enterprises superconducting horizontal magnetometer, and the magnetic susceptibility was measured with a Bartington susceptibility meter system. The demagnetization procedure using the alternating field (AF) was conducted on 128 samples over 14 incremental steps up to 100 mT.

The demagnetization experiments demonstrated the presence of the primary magnetization of normal and reverse polarity in all samples. Demagnetization results were plotted as orthogonal vectors diagrams and as equal-area projections. The paleomagnetic directions were determined using principal component analysis (Kirshvink, 1980). All interpretations and data processing were carried out using the PaleoMac software (Cogné, 2003) and Enkin's PC software (Enkin, 1996).

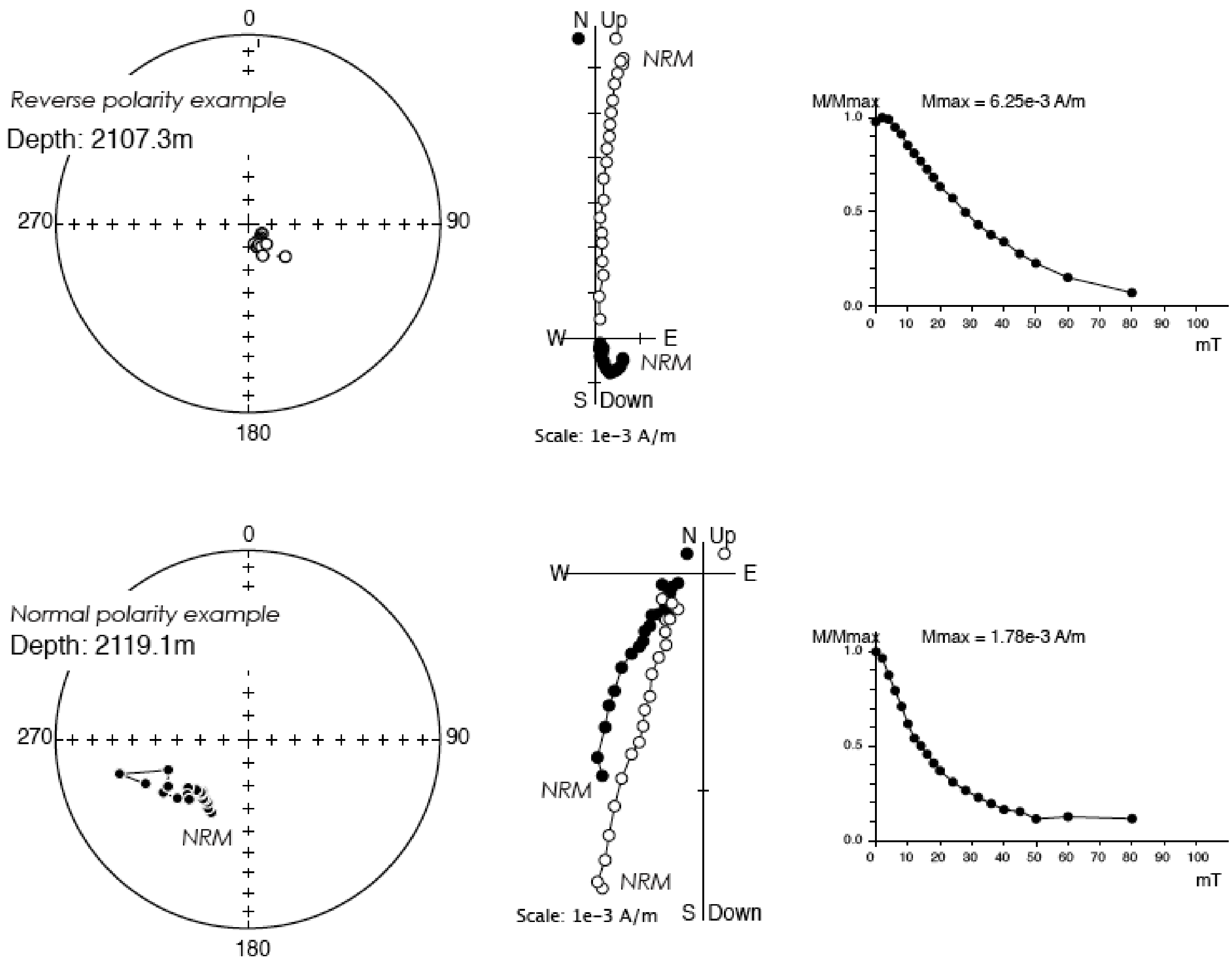

Figure 2: Results of alternating field demagnetization for the reverse and normal polarity samples from the core 12-35-79-17-W6. Left: typical equal-area projections illustrating demagnetization paths during experiments. Centre: demagnetization orthogonal vector plots. Right: normalized intensity of magnetization versus applied laboratory field in mT. Closed (open) symbols in orthogonal plots: projections onto the horizontal (vertical) plane. The core was not oriented azimuthally therefore declination is arbitrary.

Results

The studied cores indicate normal and reverse polarity intervals across the upper Montney and lower Doig formations boundary. The data are correlated between each other based on the normal and reverse polarity remnant magnetization in the measured samples. Representative examples of the reverse and normal polarity samples are shown in Fig. 2. The position of the intervals with similar characteristics along the different core depths can be determined even where interpretations based on the well-log signature correlation (gamma-ray, resistivity, seismic velocity) is ambiguous. The geomagnetic polarity correlation from this study can be matched with known intervals of the Triassic GPTS (Houselow and Muttoni, 2010) at 245 Ma (Fig. 3). The results suggest that throughout the study area the lowermost Doig phosphatic zone (Doig-Montney boundary) may occur within a single magnetostratigraphic interval. Correlation of magnetostratigraphic data with as yet unpublished biostratigraphic data indicates that the base of the Doig phosphate coincides approximately with the Olenekian-Anisian boundary (=Lower-Middle Triassic boundary).

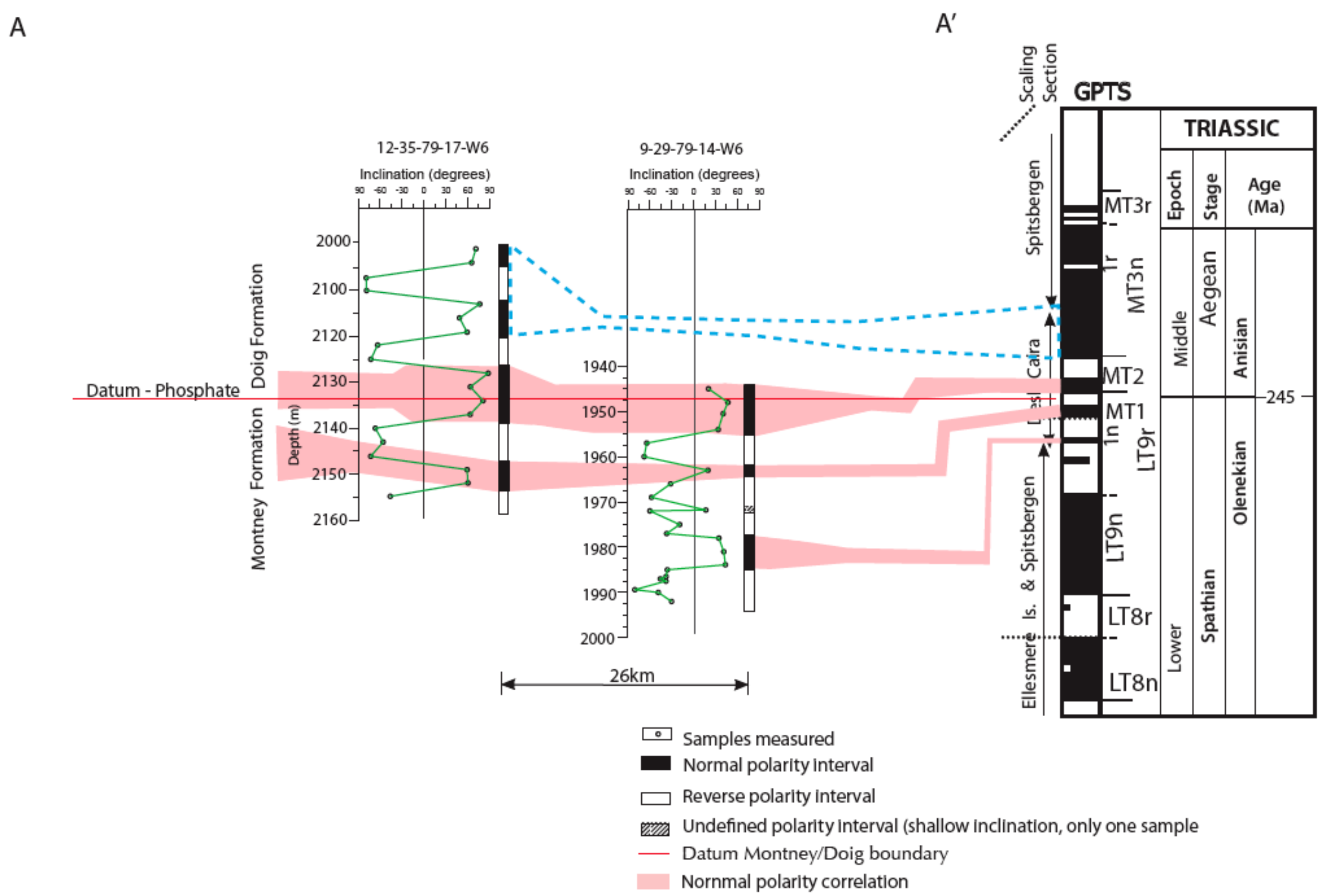

Figure 3: Paleomagnetic correlation of Lower Triassic (Lower Doig and Upper Montney formations) with known Triassic paleomagnetic data for Triassic. Cross section line (A – A') is shown on the map of study area (Fig. 1). Normal polarity and reverse polarity are correlated accordingly. The blue dashed line in this figure is a preliminary correlation because our record shows one short white (reverse) polarity interval. The GPTS does not have this interval. Triassic paleomagnetic polarity comes from Ellesmere Island composite, is from the Smith Creek and Creek of Embry sections of Ogg and Steiner (1991) and Orchard (2008). Upper Silesia composite (Nawrocki 1997; Nawrocki and Szulc 2000); Spitsbergen composite (Hounslow et al. 2008a, b; Galfetti et al. 2007b). The base of Anisian used is the first occurrence of *Cs. timorensis* in the De¸sli Caira section (Graˇdinaru et al. 2007).

Conclusions

The results from this study indicate that the lowermost Doig phosphatic zone have the same paleomagnetic record of normal polarity along the Montney and Doig formation boundary. The boundary corresponds to the normal polarity interval MT2 in the bottom of the Anisian age that starts at ~ 245 Ma. This magnetostratigraphic record suggests that the Montney - Doig formation boundary may not be as diachronous as has previously been suggested.

Presence of the primary magnetization of normal and reverse polarity in the studied Triassic sedimentary cores suggests that magnetostratigraphy can be a useful chronostratigraphic tool in these strata. The geomagnetic polarity change, which is a global phenomenon, and provides an independent means of correlation that is not reliant upon well-log interpretations.

Acknowledgements

Mike Orchard is thanked for discussions on the conodont biostratigraphy of the Montney-Doig boundary interval. Ryan Simpson and Neil Groeneveld (Arc Resources) are thanked for discussions regarding drilling methods and the stratigraphy of the upper Montney in northeastern British Columbia. Nick Wilson is thanked for discussion on regional Montney correlations and the significance of substrate-controlled trace fossil assemblages at the Montney-Doig contact. We thank paleomagnetic laboratory technician L.P. Koukhar (Department of Physics) for timely measurements of the samples.

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