

## New data on geochemistry of the Lower Jurassic (Sinemurian) shallow marine successions in British Columbia and Nevada

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### Summary

Carbon and osmium isotope samples were collected from Five Card Draw, Nevada, USA and Last Creek, British Columbia, Canada. The studied interval spans from the Involutum Zone to the Harbledownense Zone of the Sinemurian Stage (Lower Jurassic). The positive carbon isotope excursion recorded in Last Creek suggests a possible global event. The osmium isotope analysis reveals the difference of the depositional environments of the two study areas: Five Card Draw is more restricted and affected by continental influx and weathering, while Last Creek is an open ocean setting. This study is the first report on the geochemistry of the Sinemurian of western North America.

### Introduction

Early Jurassic time witnessed many geological events that had significant impacts on global environments, such as the opening of the Hispanic Corridor, global eustatic sea level rise, widespread occurrence of black shales and global anoxic events (Smith & Tipper, 1986; Hallam, 1981; Jenkyns, 1988). The purpose of this study is to understand the marine depositional environments and evaluate past changes in ocean chemistry during the Sinemurian, using powerful geochemical tools such as carbon and osmium (Os) isotopes. This study focuses on two of the best Sinemurian marine successions in North America: the Sunrise Formation at Five Card Draw (FCD) in the Gabbs Valley Range, Nevada and the Last Creek Formation at Last Creek (LC) in Taseko Lakes map area, British Columbia. At each location, two stratigraphic sections were measured and sampled for both geochemistry and biostratigraphy.

### Method

Precise temporal constraint is provided by over 90 ammonoid localities. The Five Card Draw sections span over 110m of the Sinemurian, from the Involutum Zone through the Harbledownense Zone; the Last Creek sections, coeval with FCD, span over 50m. Five Card Draw is also the type section for part of the North American Sinemurian zonation scheme (Taylor et al., 2001). The samples were cut and polished before being powdered and homogenised in either a tungsten disc mill (for TOC and  $\delta^{13}\text{C}_{\text{org}}$ ) or zirconium disc mill (for Re and Os). Once powdered, samples being analysed for TOC and  $\delta^{13}\text{C}_{\text{org}}$  were decalcified using 45 ml 3N HCl. Stable carbon isotope measurements were performed at the University of Durham using a Costech Elemental Analyser (ECS 4010) coupled to a ThermoFinnigan Delta V Advantage. Carbon-isotope ratios are corrected for  $^{17}\text{O}$  contribution and reported in standard delta ( $\delta$ ) notation in per mil (‰) relative to the VPDB scale. Total organic carbon (TOC wt. %) was obtained as part of the isotopic analysis using an internal standard (i.e., Glutamic Acid, 40.82 % C). Rhenium and osmium abundances and isotopic compositions were obtained in the TOTAL Laboratory for Source Rock Geochronology and Geochemistry, part of the University of Durham Geochemistry Group following the protocol outlined by Selby and Creaser (2003).

## Examples

The measured sections are coded as FCD 1 and FCD 2 in Five Card Draw, and LC 1 and LC 2 in Last Creek. The TOC concentration for both FCD and LC are generally low and without much variation in all samples except some minor peaks, ranging from 0.03-2.77 wt. % and 0.01-3.05 wt. % respectively. Of particular interest are sections FCD 1 and LC 2 within the upper part of the Leslei Zone. At this level, both sections exhibit significantly different carbon isotope profiles, with  $\delta^{13}\text{C}_{\text{org}}$  values at FCD 1 remaining relatively continuous at  $\sim -25$  to  $-26$  per mil, contrasting with those at LC 2 that shift gradually from  $\sim -27$  per mil to  $-24$  per mil. Further, the gradual positive trend observed at LC 2 corresponds to a comparable and coeval positive shift seen in shales in Dorset, UK (Jenkyns and Weedon, 2013). This suggests that the sediments in LC 2 record a potentially global carbon isotope signal at this time that may reflect an increase in global ocean primary productivity. Why then is this signal not also observed at FCD? Using Os isotopes, it is possible to quantitatively demonstrate that the two sections were deposited under contrasting depositional conditions. LC 2 indicates an open ocean environment, while FCD 1 was partially restricted on the continental margin with significant input from continental weathering, which is likely to have dictated the differences observed between the two carbon isotope profiles.

## Conclusions

Carbon and Osmium isotope analyses suggest that the Sinemurian succession in Last Creek records a possible global positive carbon isotope excursion during the latest Early Sinemurian, which can be correlated with the excursion recognized by Jenkyns and Weedon (2013) in the UK. A likely causal factor for this CIE may have been a widespread increase in primary productivity. The data also suggest the ocean environment in Five Card Draw was quite different from that of Last Creek during Sinemurian time. It was a partially restricted basin influenced by significant continental inundation, which probably masked the positive CIE.

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