Variations in depositional environments reconstructed by biomarkers analysis of turbidite sediments from the Miocene Kawabata Formation, Hokkaido, Japan

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The Miocene Kawabata Formation, exposed in Yubari, central Hokkaido, Japan, is described as basin filled and slope-apron turbiditic systems mainly dominated by siliclastic sediments (Kawakami *et al.*,2002). A previous study done by Furota *et al.*(2014), discovered plant fragment (PF) concentrated sandstones known as hyperpycnites, which are land-derived flood deposits abundant in terrigenous organic matter (Zavala and Arcuri, 2016). The objectives of this study are (1) to reconstruct the paleoenvironment and depositional system of a key outcrop of the Kawabata Formation, and; (2) to reconstruct variations in biomarker data in the Kawabata Formation during ca. 15-12 Ma.

The Kawabata Formation consists of siliclastic sediments with PF concentrated sandstones and are partially exposed by the Soumokumai-zawa River along a 1200m transect in central Hokkaido, Japan. The Chidorigataki outcrop is a key outcrop for evaluating the paleodepositional environment and depositional system by using sedimentological data along with biomarker analysis. Data of older parts, in the Soumokumai-zawa section were added in from previous data made available by Okano and Sawada (2007) and Furota (2017).

The 145cm thick Chidorigataki outcrop turbiditic sequence is interpreted to have been deposited by three flooding events, generally producing fining up sequences having an erosive, sandy (PF concentrated sandstone) base overlain by mud or sandy mud. The redox indicator - pristane/phytane (Pr/Ph) ratio - shows higher (more oxic) values in PF concentrated sandstones and lower (less oxic/more anoxic) values in mudstones. The $C_{27}/(C_{27}+C_{29})$ sterane ratios, used to determine the source of organic matter, shows lower values (high terrigenous organic matter input) in PF concentrated sandstones. Other terrigenous organic matter such as the oleanane and lupane triterpenoids, and their degraded aromatic counterparts were also present throughout the succession, suggesting that the sediments were derived from the terrestrial realm. TOC% averaged at 0.47% for mudstones and 3.22% for PF concentrated sandstones. Highly branched isoprenoid (HBI) alkanes were also found throughout the succession, suggesting the presence of diatom-derived organic matter. In terms of sedimentology, a dispersed type PF concentrated sandstone was discovered underlaying laminar type PF concentrated sandstones, suggesting that sediments were transported in high density flow conditions overlain by lower density flow conditions.

In the mudstone samples from the Soumokumai-zawa River, there was a gentle increase in Pr/Ph . This result suggests that they were deposited in more oxic conditions. As for $C_{27}/(C_{27}+C_{29})$ ratio, there was a gentle decrease, suggesting a higher input of terrestrial organic matter. Interestingly, higher $C_{27}/(C_{27}+C_{29}$) values were seen in rocks containing the diatom-derived HBI molecule. This could be due to an increase in diatom productivity in the region (Barron, 1998; Yamamoto et al., 1999) during the transitional global climate period of the Miocene.

This study suggests that both the Chidorigataki outcrop and the Soumokumai-zawa section of the

Kawabata Formation were deposited by terrestrial derived sedimentary systems to the deep sea, as seen by the highly oxic character (due to freshwater input) and high amounts of terrestrial organic matter with minor marine input.

Keywords: turbidite, biomarker, sedimentology, organic geochemistry, Kawabata Formation, density flows

