**Electronic supplement**

This electronic supplement consists of:

1. Supporting semi-quantitative X-ray diffraction (XRD) data;

2. Supporting chemical data;

3. Comparison of mudrocks with associated sandstones

1. **Supporting semi-quantitative X-ray diffraction (XRD) data**

The data used in the paper are in Tables S1 and S2.

2. **Supporting chemical data**

Additional plots of major element oxides are given in Figures S1-S6.

3*.* **Comparison of mudrocks with associated sandstones**

A large chemical data-base is available for sandstones that occur in the same units as the mudrocks studied here (Robertson & Palamkumbura this volume c). Interbedded mudrocks and sandstones could have identical or different provenance. For example, in deep-sea deposits turbidites could have a different provenance from associated hemipelagic sediments that could additionally include aeolian and hydrogenous (directly precipitated) material. On the other hand, turbidites and their fine-grained fallout should be of more similar composition. However, different constituents are concentrated in different size fractions, for example micas and clay minerals (and related elements) in the fine fraction (e.g. Miall l996). In addition, some mudrocks or sandstones may have intrabasinal or recycled origins.

To help shed light on provenance, the Maitai Group and Patuki Melange mudrocks are compared below with the chemical composition of sandstones from the same units using data from (Robertson & Palamakumbura this volume c).

Using the well-known discrimination diagrams (see the text), for the XRF data (Fig. S7) most of the mudrocks plot within, or near, the field of overall sandstone composition. For the Wooded Peak Formation, the mudrocks plot within a relatively primitive field and a relatively evolved field (Fig. S7 a, b). These two compositions broadly correspond to sediments with relatively abundant quartz, feldspar and mica (Humboldt petrofacies) versus those with relatively abundant clinopyroxene and feldspar (McKellar petrofacies) (Landis l974; Owen l995; see also Robertson & Palamakumbura this volume b). The Tramway Formation mudstones are very similar to interbedded sandstones (Fig. S7 c, d). The mudrocks of the Little Ben Formation plot outside the relatively restricted, chemically depleted compositional field of the sandstones, which are rich in basaltic-andesitic rock detritus and related ferromagnesian minerals (e.g. clinopyroxene). Similar patterns are shown by the overlying Greville Formation (Fig. S7 g, h) and the Waiua Formation (Fig. S7 i, j), in which the mudrocks are depleted relative to the sandstones. For the Stephens Subgroup (Fig. S7 k,l), the compositions of the mudrocks and the sandstone are virtually indistinguishable, suggesting the same source, without significant differentiation during deposition.

For the REE data the mudrocks and sandstones of the Wooded Peak Formation, Tramway Formation, Greville Formation, and Waiua Formations are similar (Fig. S8 a-l), whereas the Little Ben Formation differs markedly. The Stephens Subgroup mudrocks and sandstone are similar on the La-Th-Sc plot but differ on the La-Th plot, with the majority of the mudrock samples plotting in the continental island arc field (CIA).

The sandstones and shales of the Patuki Melange have similar compositional ranges (Fig. S9 a-d), although the shales do not replicate the complete range of the sandstone composition, which is not surprising as the number of sandstones is much greater (see Robertson & Palamakumbura this volume b).

Overall, the sandstones and shales show many compositional similarities but also differences. A much greater number of mudrock analyses would be need to a more detailed comparison.

**References**

Landis, C.A. 1974. Stratigraphy, lithology, structure and metamorphism of Permian, Triassic and Tertiary rocks between the Mararoa River and Mount Snowdon, western Southland, New Zealand. Journal of the Royal Society of New Zealand 4: 229-251.

Miall, A.D. 2013. Principles of Sedimentary Basin Analysis, 3rd edition, Springer (New York).

Owen, S.R. 1995. Maitai and Murihiku (Permian and Triassic) rocks in Nelson, New Zealand. Unpublished PhD thesis, University of Otago.

Robertson, A.H.F. & Palamakumbura, R.N. Sedimentary development of the Mid-Permian to Mid-Triassic Maitai continental margin fore-arc basin, South Island, New Zealand, this volume b.

Robertson, A.H.F. & Palamakumbura, R.N. Sedimentary geochemistry used to infer provenance of Permian-Triassic deep-marine sandstones related to the SE-Gondwana active continental margin, South Island, New Zealand, this volume c.