# Aeolian Sandstones of the Upper Triassic Fundy Basin, Nova Scotia, Canada.

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## Summary

In this study, we provide a lithostratigraphic account of the Red Head Sandstone (RHS). Located on the northern shore of the Minas Subbasin, the Red Head type section comprises ~ 33 m of quartzitic aeolian sandstones deposited in an arid to semi-arid environment during the Late Triassic. The sandstone occurs at the transition between the alluvial/fluvial Wolfville Formation and playa-lacustrine mudstones of the Blomidon Formation in the Minas Subbasin. Because of this transitional relationship, there are uncertainties associated with the host formation of the RHS.

Informally called the Red Head member, literature review shows that there have been inconsistencies surrounding the host formation of the aeolian sandstone, which has affected its lithostratigraphic designation. Earlier authors report the sandstone as the uppermost unit of the Wolfville Formation (Hubert & Mertz 1980, 1984; Olsen 1997, Olsen & Et-Touhami 2008; Leleu et al. 2009, 2016; Leleu & Hartley 2010). However, much recent stratigraphic review from the Fundy Basin suggests that the sandstone constitutes a member of the playa lacustrine Blomidon Formation (Sues & Olsen, 2015). Given the considerable biostratigraphic support which plays little part in the definition of lithostratigraphic units in this recent review, a formal definition and description of the RHS in accordance with the guidelines of the International Subcommission on Stratigraphic Classification is recommended.

Although each lithostratigraphic unit formed at a specific geologic time interval, their stratigraphic classification depends on their lithologic properties that are heavily controlled by their depositional conditions. Therefore, the differences in facies between the RHS and adjacent playa lacustrine mudstones of the Blomidon Formation from field observation suggests that the Red Head Sandstone represents a spatial change in localized depositional process. A comprehensive literature review, detailed sedimentological description and analysis of outcrop samples are used in this study to re-evaluate the host formation of the RHS.

## Theory

The Red Head Sandstones occur between the fluvial Wolfville Formation and the lacustrine Blomidon Formation close to the basin border fault in the northern Minas Subbasin (Figure 1). It comprises approximately 33 m of dune sandstones (Nadon & Middleton, 1984) interpreted as deposited under primarily aeolian conditions that occurs as coastal exposures between Red Head Point and Lower Economy along the northern margins of Minas Subbasin (Hubert & Mertz, 1980, 1984). At its type section (Figure 2), a maximum logged thickness of 15 m was measured for the variably dipping strata that is conformably overlain by laminated playa lake mudstone facies of the Blomidon Formation with the top of the strata marked by the disappearance of the aeolian sandsheets and the emergence of flat and regular bedded mudstone cycles (Martyns-Yellowe et al., 2021 *in prep*). The dune strata is comparable to aeolian dunes deposited along the conjugate margins of Morocco and reflect a shift in climate towards more arid conditions (Redfern et al., 2010). Stratigraphically, the dune strata is separated from the overlying lacustrine deposits of the Blomidon Formation by an unconformity visible at its type section (Martyns-Yellowe et al., 2021 *in prep*). The unit is contemporaneous with Upper Triassic aeolian strata deposited in rift basins along the conjugate margins of Morocco (Olsen et Tahoumi., 2008).

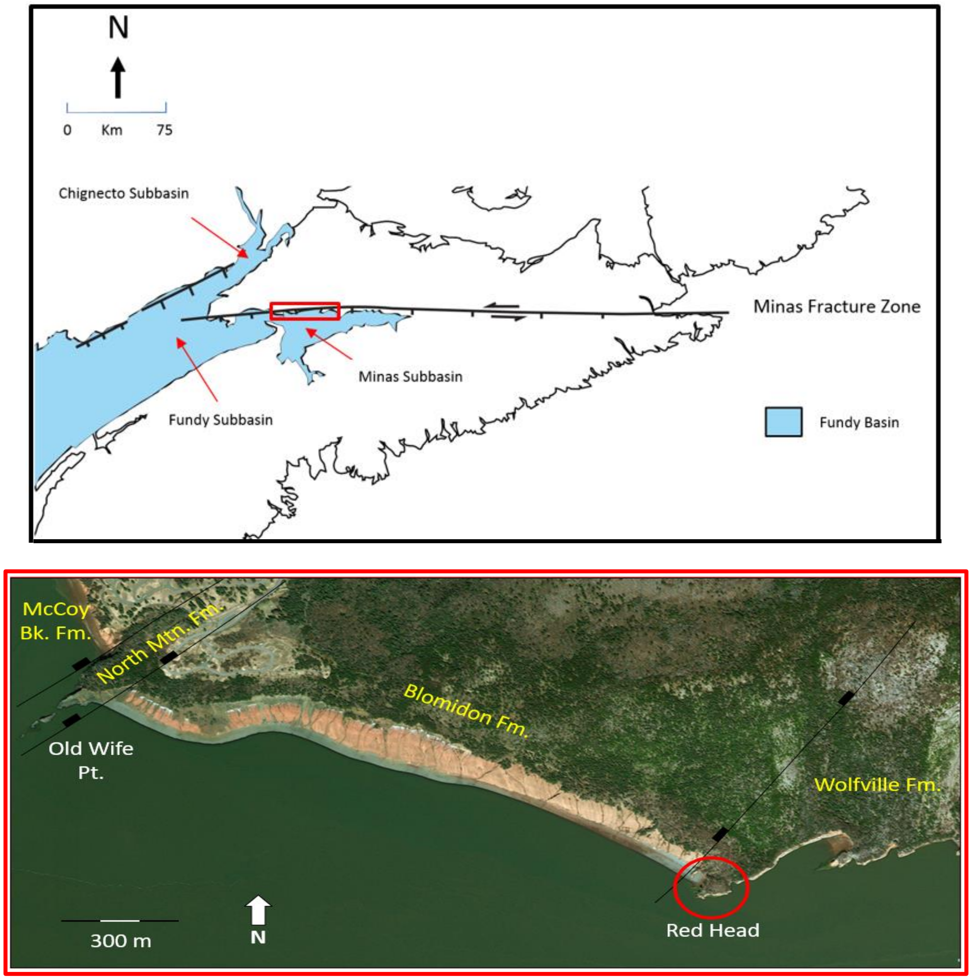


**Figure 1:** Map of the Fundy Basin showing the three contiguous components (Fundy Subbasin, Minas Subbasin and the Chignecto Subbasin). The major bounding Minas Fracture Zone shows a predominantly sinistral strike-slip motion (Modified from Schlische, 1993). In the aerial photograph below the map, the red oval represents the location of our study section at Five Islands.

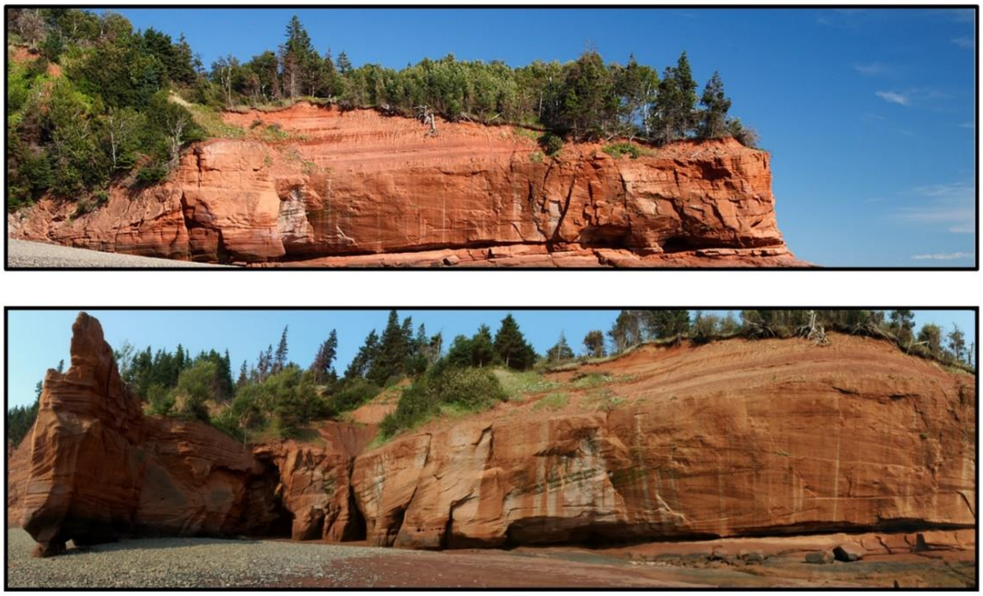

**Figure 2**: Outcrop photo of the Red Head Sandstone type section west of Lower Economy at Five Islands (O'Connor, 2016).

## Results, Observations, Conclusions

The RHS plots between subarkose and sublithic arenites and in the recycled orogeny field in the QtFL plot (Figure 3) with recalculated parameters after Ingersoll and Suczek (1979), and Dickinson (1985) and is divided between subarkose and sublitharenites (mainly subarkosic) in Figure 4.

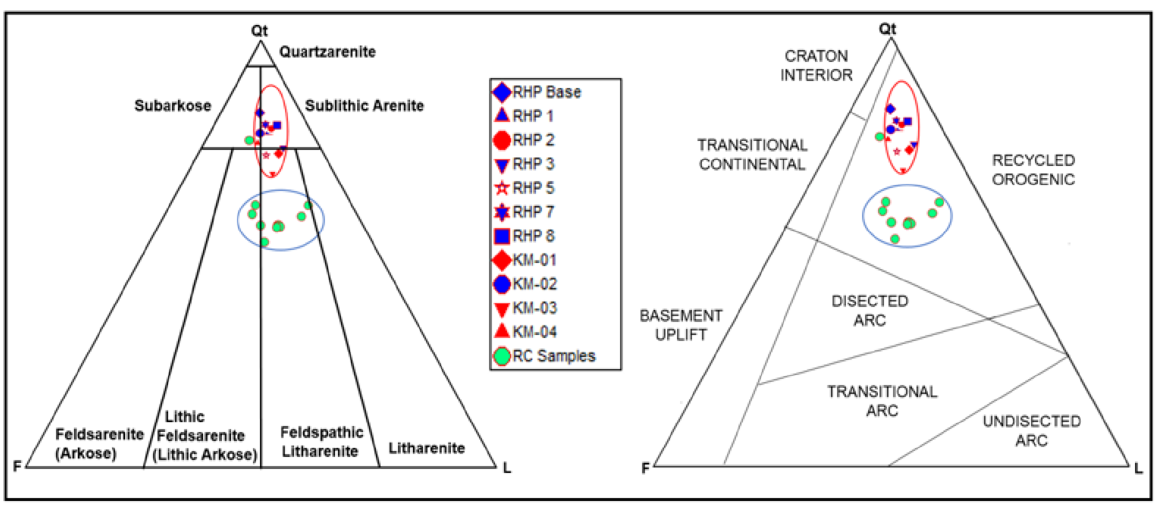


**Figure 3:** A QtFL classification of Folk (1968) and provenance indicator plot after Ingersoll and Suczek (1979) and Dickinson (1985) for the RHS. Based on the Folk classification diagram, the RHS samples plot between subarkose and sublithic arenites. For comparison, the fluvial Wolfville Formation sandstone plots between the lithic feldsarenite and feldspathic litharenites (mainly feldspathic litharenites). From the provenance indicator plot the aeolian sandstones plot in the field of recycled orogen.

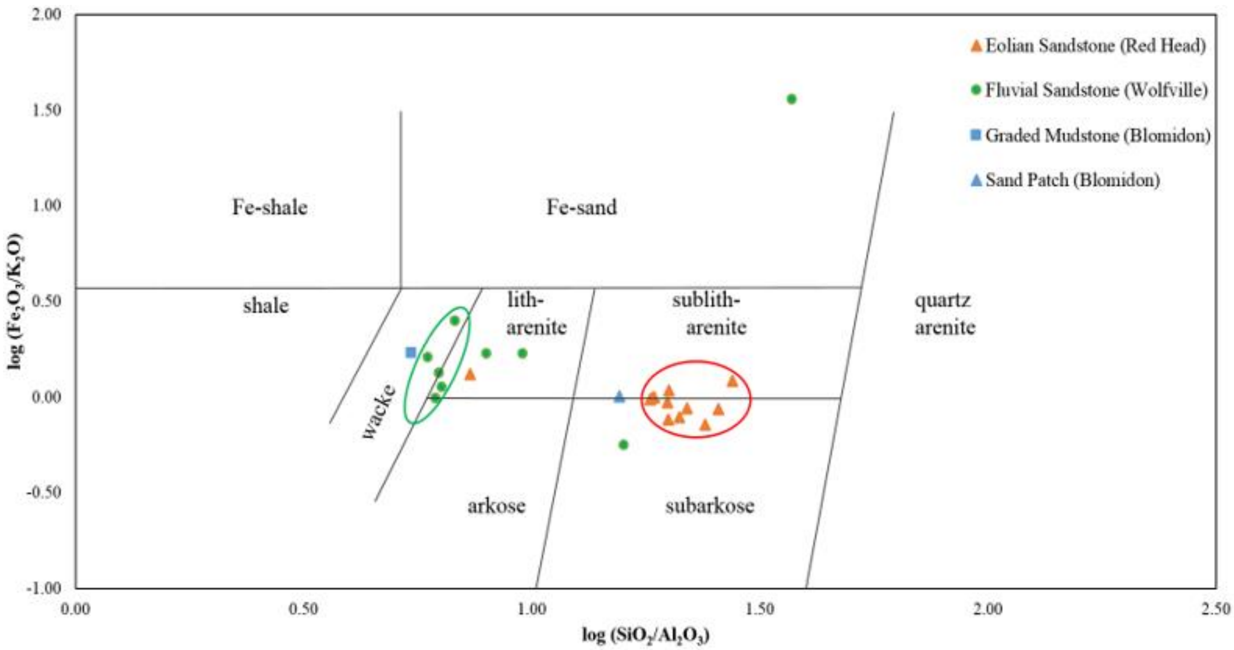


**Figure 4:** A Sand class plot (After Herron, 1988) showing the RHS divided between subarkose and sublitharenites (mainly subarkosic). In comparison, the Wolfville Formation sandstones plot mainly in the litharenite field. Two mudstone samples from the Blomidon Formation plotted in the wacke field (for the graded mudstone) and the boundary between subarkose and sublitharenites (for the sandpatch mudstone).

Mudstone samples from the Blomidon Formation shows more matrix porosity and exhibits a predominance of matrix supported quartz, mica, and significant amounts of iron oxides (Figure 5a). The observed variation in grain size, ranging from mudstone to very fine sandstones, with good sorting in the Blomidon mudstones suggests that it is texturally different from the RHS. The RHS is more texturally and compositionally mature. Petrographic analysis of sandstone samples from the RHS supports its aeolian transport with thin section and point count analysis revealing enhanced levels of primary porosity (Figure 5b). The presence of few chemically unstable feldspars and little to no clay constituents in the RHS observed from both petrographic thin section and geochemical analysis tables emphasizes high intensity weathering associated with their aeolian transport. Compared to the fluvially derived underlying sandstones of the Wolfville Formation studied by Kettanah et al. (2014), the fluvial sandstones are grain supported, rich in calcite cement with low porosity distribution and minor amounts of iron oxides and clays (Figure 5c).

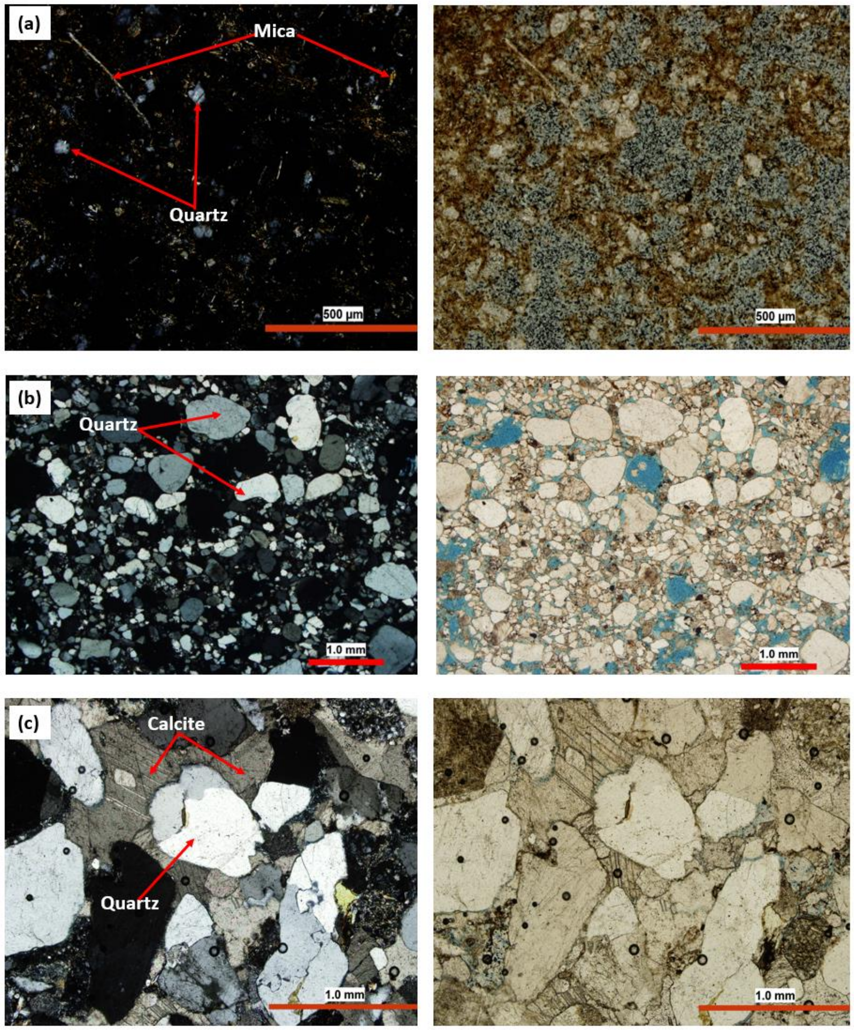


**Figure 5:** Photomicrograph comparing the grain size variation, mineralogical distribution and sorting in the (a) Blomidon Formation mudstones (b) RHS and (c) Alluvial/Fluvial Wolfville Formation Sandstone. Note the bimodal distribution of grains as well as the preferential orientation of larger grains in the RHS.

In conclusion, the RHS is a product of extensive weathering, reworking and remobilization of older sediments of distal fluvial Wolfville Formation sandstones likely occurring shortly after the deposition of the Wolfville Formation Sandstones in the Middle Norian (Kettanah et al., 2014). Field sedimentological and lithological observation of the Red Head Sandstone and the Blomidon Formation this study indicates that the RHS possesses different sedimentary characteristic from adjacent mudstones of the Blomidon Formation. Additionally, the aeolian sandstone is laterally dissimilar from fluvial sandstones of the Wolfville Formation. Thus, while the sandstone appears not to be a stratigraphic member of the Blomidon Formation, its relationship to the Wolfville formation is questionable on the basis of lithological characteristics.

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