Easter Rova Head, Shetland

[HU 475 454]

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Introduction

The sea cliffs and rocky foreshore around Easter Rova Head, about 4 km north of Lerwick on the east coast of Shetland Mainland, provide extensive exposures of spectacular, coarse cobble and boulder conglomerates. Together with subordinate sandstone interbeds, the conglomerates comprise the Rova Head Conglomerate Formation, of Mid-Devonian, probably Givetian, age. The formation is considered to comprise mainly sheet-flood deposits, with some mass-flow beds, that accumulated in an alluvial fan at the margin of a lake. It lies close to the base of the local Devonian sequence, unconformably overlying metamorphic basement.

The regional importance of the Easter Rova Head site lies in the unique insight it provides into Mid-Devonian alluvial environments and processes. Understanding of these allows a better interpretation of otherwise little-known aspects of the stratigraphy and tectonic framework of the Orcadian Basin. Overviews of the geology are provided by Mykura (1976) and Allen and Marshall (1981). A detailed sedimentological account of the site is given by Allen (1981a).

Description

At Easter Rova Head, the spectacularly coarse Rova Head Conglomerate Formation is well exposed in low sea-cliffs and across a rocky foreshore. The GCR site covers the island and the contiguous coastal outcrops on the mainland (Figure 2.18). Within the site area, the conglomerates and interbedded sandstones dip moderately to the southeast so that a vertical thickness of about 150 m is represented. The formation lies close to the base of the Devonian succession of eastern Shetland, within the structural tract east of the Nesting Fault (Figure 2.7) and is regarded as probably Givetian (Mid-Devonian) in age.

The clasts of the Rova Head Conglomerate Formation are rounded to well-rounded, generally with a moderate to high sphericity. They range up to about 75 cm in diameter and are poorly sorted. Quartzite is the most abundant clast lithology, but vein quartz and various granitic types are well represented, together with lesser amounts of psammite, felsite, schist and foliated granodiorite. Allen (1981a) recognized three types of conglomerate:

1. Clast- (or framework-) supported conglomerate, inversely graded at the base of the bed, ungraded and only crudely stratified in the centre of the bed, and normally graded at the top of the bed. This is the commonest type in the formation.
2. Matrix-rich or matrix-supported conglomerate, either ungraded or with inverse grading.
3. Clast- (or framework-) supported conglomerate with normal grading.

All three types occur at all levels in the succession, but there appears to be an up-sequence increase in the proportion of clast-supported types. However, many of the conglomerate beds have ambiguous characteristics and are not readily assigned to a specific category.

The lowest conglomerates within the site are seen at its north-west margin, along the shore of the North Bight of Rovahead. There, conglomerate beds range up to about 2 m, separated by thin sandstone beds and lenses up to about 20 cm thick (Figure 2.19). The conglomerates are variably matrix- or clast-supported, with both textures commonly present in the same bed where pockets of pebbles are concentrated in an otherwise matrix-rich background. Some of the beds are normally graded and fine upwards, but others have a well-developed, inversely graded, upward-coarsening trend. There is some sporadic, but seemingly irregular pebble imbrication. Both the matrix and the sandstone interbeds consist of coarse-grained sand, and the interbeds show planar and cross-lamination. There are sporadic thin beds of

fine-grained sandstone and red siltstone, the latter containing desiccation cracks (Allen, 1981a). A graphic log of this part of the succession by Allen (1981a) is shown in (Figure 2.20)A.

Higher in the succession, along strike from the lighthouse and towards the South Bight of Rovahead, there is a tendency for the conglomerates to be clast-supported rather than matrix-rich (Figure 2.21). There is also an overall up-sequence (SE-directed) trend to thinner beds (although still ranging up to about 2 m maximum thickness), a smaller proportion of conglomerate relative to sandstone (although conglomerate remains by far the major lithology) and a lower maximum clast size (Allen, 1981a). Some beds thin north-eastward, along strike. There are apparently no systematic changes, either with stratigraphical level or laterally, in clast compositional range, shape or modal size. Sandstone interbeds in the higher part of the sequence are rather more extensive than those lower down, but there are no compositional or textural changes, and both planar and cross-stratified beds are present throughout. A graphic log of the higher part of the succession within the GCR site, taken from Allen (1981a), is shown in (Figure 2.20)B.

Interpretation

The Rova Head Conglomerate Formation lies close to the base of the Devonian succession and interdigitates laterally towards the southwest with a breccia derived from, and believed to unconformably overlie, a basement of metamorphic rocks (Mykura, 1976). Palaeocurrent analysis shows the conglomerates and interbedded sandstones to have been derived from a broadly western source. Mykura (1976) recorded regional palaeocurrent flow towards the south-east, whereas Allen (1981a), in a more extensive and detailed study, demonstrated that palaeocurrent flow at Rova Head was broadly towards the north-east. From petrological and Sm-Nd isotope studies, Knudsen (2000) identified relatively local basement sources for the clast assemblage, all to the east of the Walls Boundary Fault and within the same structural tract as the Devonian strata.

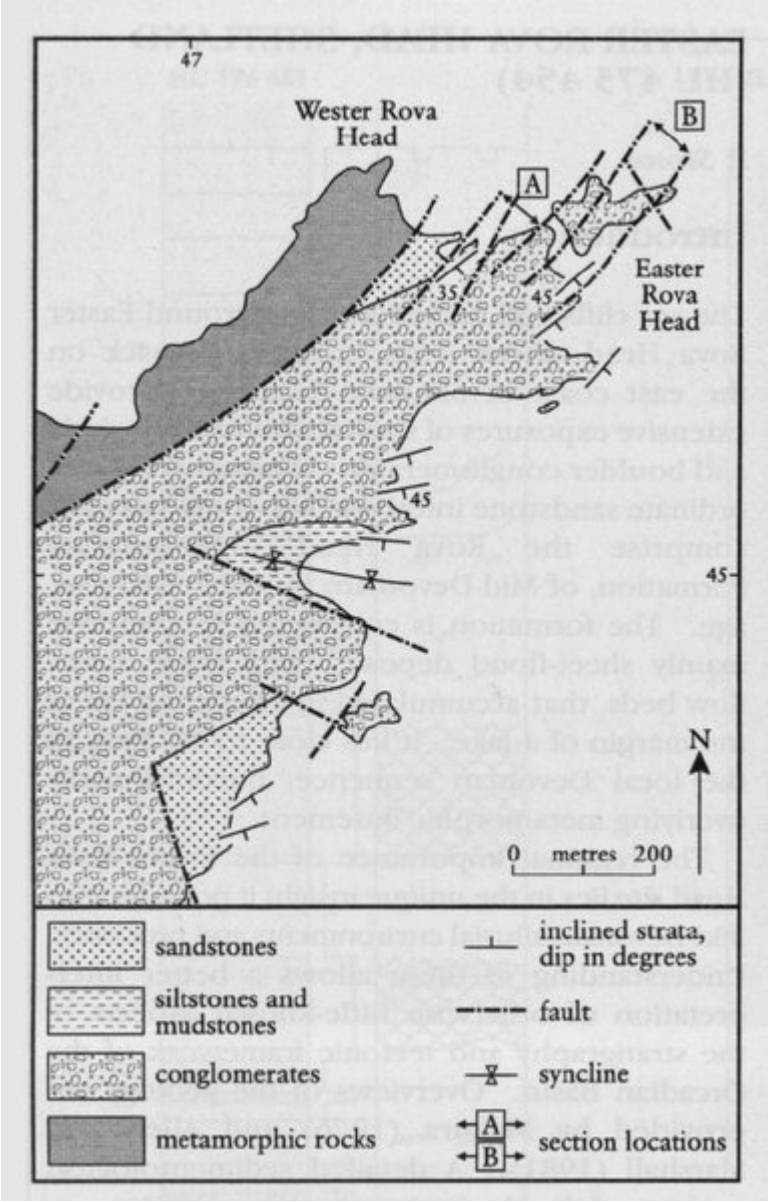
Allen (1981a) concluded that the Rova Head conglomerates accumulated as successive sheet-flood deposits in a low-inclination alluvial fan at the margin of a lake. The inverse to normally graded, mostly clast-supported conglomerates were deposited as thick sheets and bars on a surface with little topographic relief. Finer material was rapidly transported during rising flood conditions and deposited as poorly sorted, unstratified gravels. As the flood developed, increased water flow transported and deposited coarser material, producing inverse grading. As the flood waned, normal grading and horizontal stratification were produced in progressively decreasing concentrations of sediment. The matrix-supported conglomerates, many of which are inversely graded, record high-concentration, mass-flow events.

Sand wedges were deposited over and against the coarse gravel bodies as the current flow waned. Thicker interbeds of horizontally or cross-laminated sandstone represent the migration of sand waves over the gravel bodies and are probably unrelated to the sheet-flood events. However, some of the most extensive sandstone units may have been deposited during small sheet-floods restricted to broad, shallow channels. Flood events may have also produced overbank floodplain deposition, represented by the sporadic red siltstone interbeds. Desiccation cracks in these siltstones show that the floodplain was subjected to periodic subaerial conditions in an arid climate (Allen, 1981a).

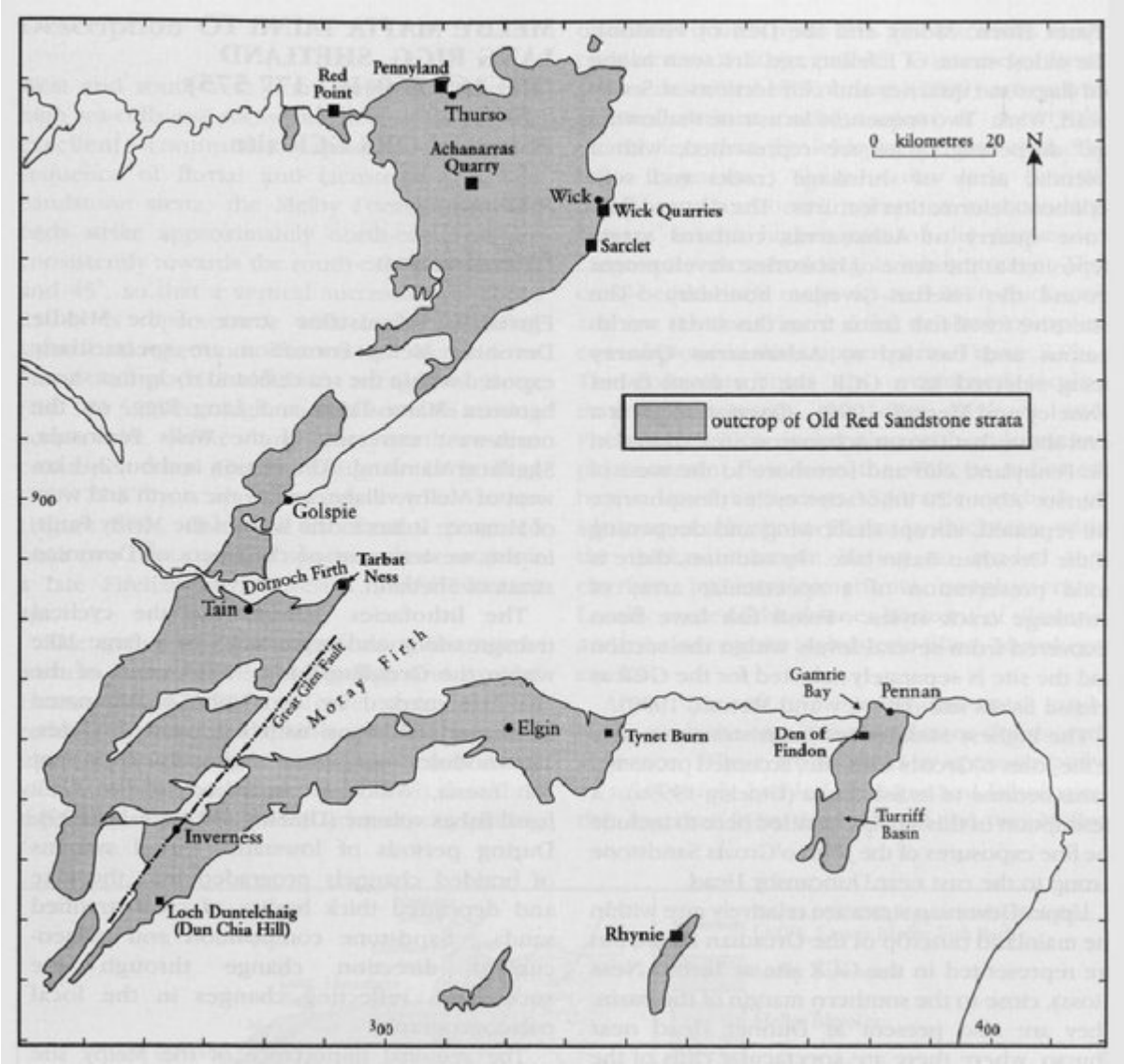
Conclusions

The Easter Rova Head GCR site provides a well-exposed and instructive section through part of an alluvial-fan sequence developed at the margins of a Mid-Devonian lake. The conglomerate sequence, with subordinate sandstone and siltstone, illustrates a range of depositional processes within an environment dominated by sheet floods. High-concentration, mass-flow conglomerates alternate with those recording rising and waning flood conditions. Between flood events, sand waves migrated across the conglomerate bodies in channelized fluvial deposition, and fine-grained overbank deposition and subaerial conditions were intermittently established. The conglomerates have a local source, and their presence provides an important control on the geometry of the depositional basin and its geotectonic evolution. The site is therefore of great importance in the regional understanding of the Orcadian Basin.

References

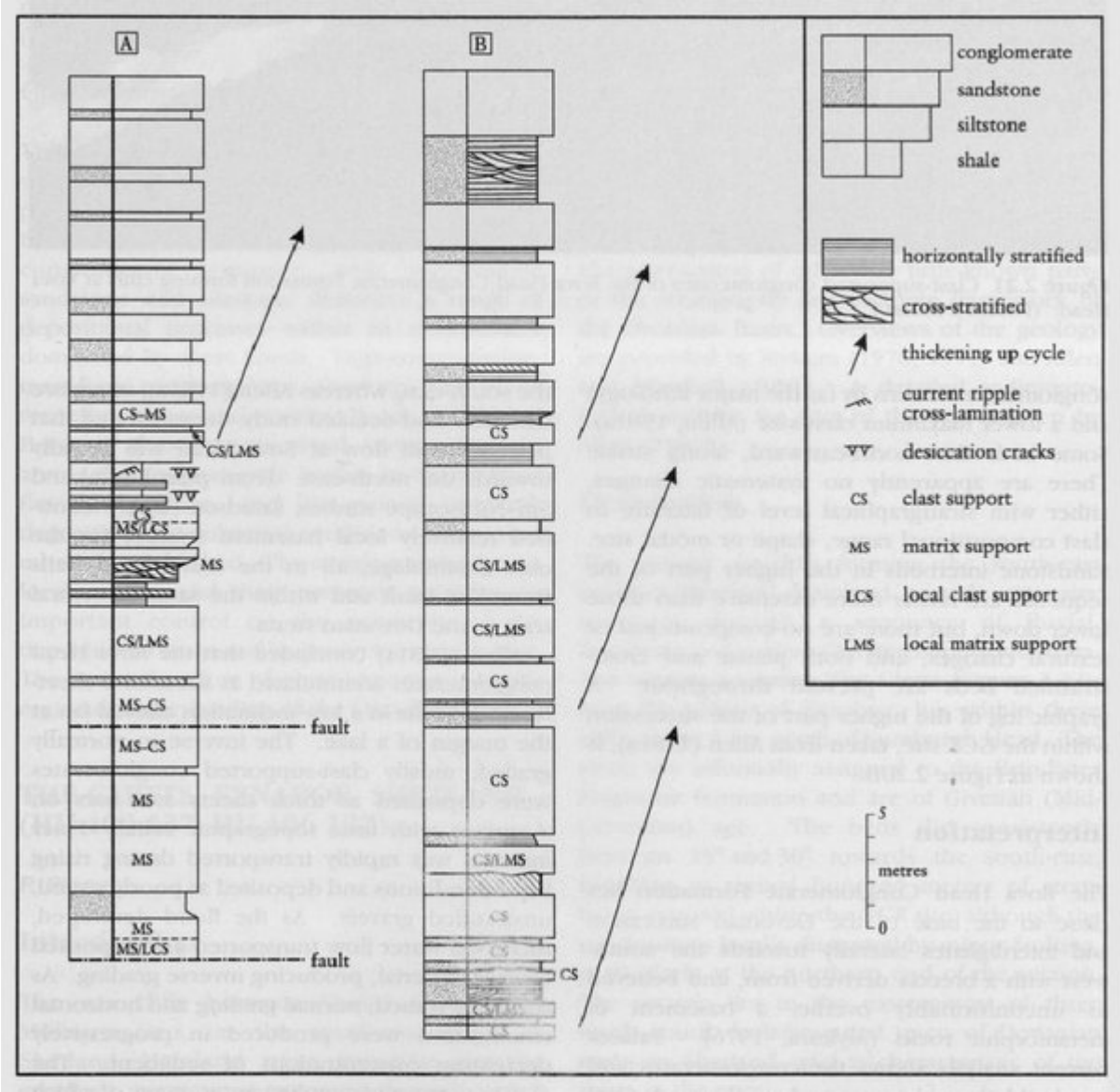


(Figure 2.18) Outline geology of the Rova Head area. After Allen (1981a).

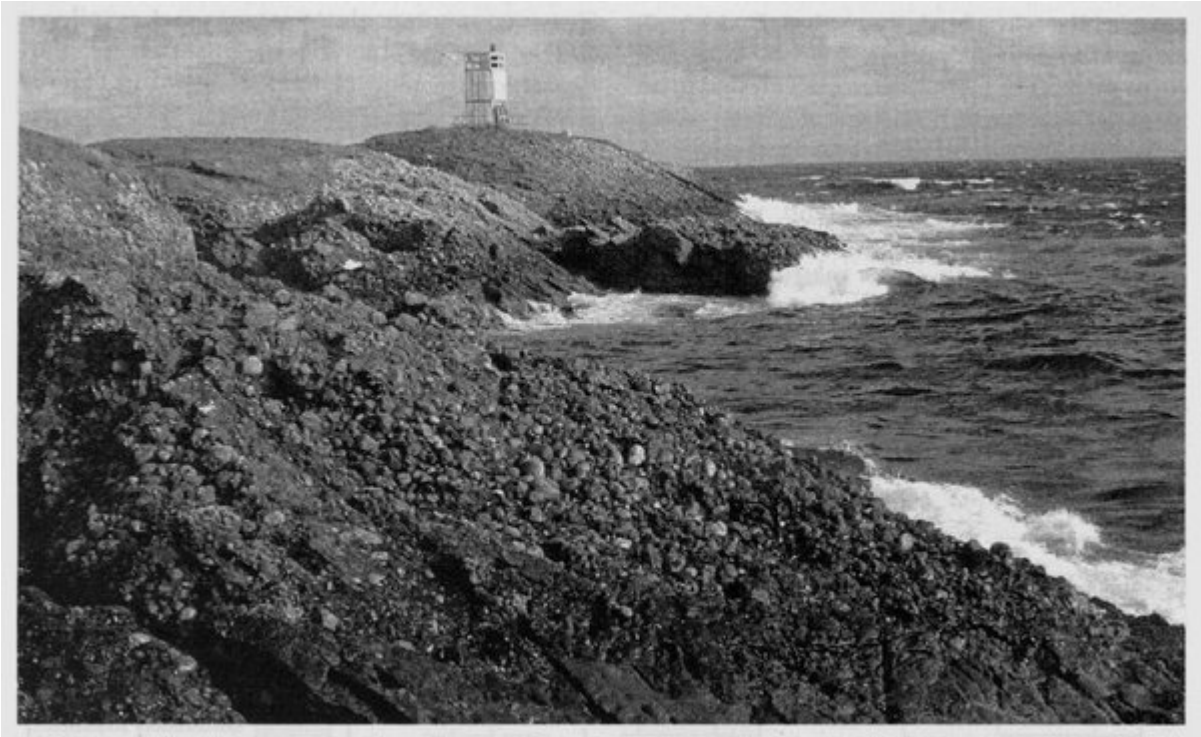


(Figure 2.7) Old Red Sandstone outcrops in north-east Scotland and locations of GCR sites.

(Figure 2.19) Variably matrix- and clast-supported conglomerates with sandstone interbeds of the Rova Head Conglomerate Formation. (Photo: P. Stone.)



(Figure 2.20) Graphic logs of part of the ;?(Iva Head succession. See (Figure 2.18) for the location of sections A and B. After Allen (1981a).



(Figure 2.21) Clast-supported conglomerates of the Rova Head Conglomerate Formation forming cliffs at Rova Head. (Photo: P. Stone.)