SHORT REPORTS

Terminological Debate in the Upper Hunter Valley: Indurated Mudstone versus Tuff

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Abstract

Archaeologists have variously used the terms 'indurated mudstone' and 'tuff' as a description for the fine-textured, very hard, yellowish, orange, reddish-brown or grey rocks from the upper Hunter Valley from which many of the stone artefacts there were made. The desire of archaeologists working in the region to offer a precise and accurate geological description of this material has fuelled debate about whether 'tuff' or 'mudstone' is the most appropriate label. Some of the samples of these problematic rocks that we have examined petrograhically are definitely not tuff. Until much more is known about the range of lithologies represented in this group of rocks, and ways are developed to distinguish between them, the term 'IMT' ('indurated mudstone/tuff') is an acceptable alternative to the term 'mudstone' as a description for these fine-grained rocks.

Context for the Debate

In archaeological sites in the upper Hunter Valley most artefacts are made from two rock types. One is silcrete, the other is a distinctive fine-textured, very hard, yellowish, orange, reddish-brown or grey rock that has a thin, generally smooth, dark-brownish or yellowish-brown weathered patina. This rock often has very good flaking qualities, enabling knappers to strike off both thick and thin flakes with precision, to undertake extended core reduction and to manufacture burinates and backed artefacts. For several decades there has been ongoing disagreement among archaeologists about what to call this rock, a debate that stems from different approaches to classification which are discussed below. Some archaeologists have called the rock a 'tuff', and others have called it a 'mudstone'.

Many consulting archaeologists working in the Hunter Valley describe this material as a tuff. For example Scarp Archaeology (2009:35), working at the Warkworth Sand site, identified one of the two most common raw materials as 'silicified tuff'. This terminology stems from the interpretations made by Kuskie and Kamminga (2000). They had 31 samples of rock from both the lower and upper Hunter Valley analysed by x-ray diffraction and thin-section analysis. They concluded that almost all specimens were either silcrete or were fine-grained acid volcanic rocks of rhyolitic composition. For the latter group they recommended the term 'indurated rhyolitic tuff' be used for all specimens of this kind, 'indurated' being a technical term for hardening which has taken place since the sediment was deposited. In their report Kuskie and Kamminga (2000) briefly describe the nature and origin of this rhyolitic tuff, explaining that it is a fine-grained homogenous stone formed from ash clouds ejected during explosive volcanic eruptions. After burial, some tuff beds become further indurated through low-grade metamorphic processes (probably involving pressure) in which the stone recrystallises. Tuffs occur in widespread seams throughout the Hunter Valley and indeed are common in the broader Sydney Basin, especially in Permian rocks.

Another tradition of nomenclature has been employed since the early 1980s, as we and other archaeologists referred to this material as 'mudstone' or 'indurated mudstone'. A mudstone is a sedimentary rock which consists of a mixture of silt and clay. The term 'indurated mudstone' describes the nature of the material without inferring the origin of the sediment or the cause of the induration. Hence the silt and clay in any specimen might have diverse origins including particles eroded from volcanic deposits. However, we argue that because this term does not imply a single origin for all specimens of this material it has value in the Hunter Valley context.

Thin-Section Studies

Thin-section studies of rocks from the upper Hunter Valley commissioned by the authors demonstrate lithological diversity of rocks that have much the same colour and texture. Our evidence for this comes from thin-section analysis of three samples of this material undertaken in 1984 by Watchman (Hughes 1984) and a fourth sample analysed in 2000 by Geochempet Services. Descriptions of these samples are provided in Table 1. Both Watchman and Geochempet Services used standard petrographic techniques in which thin-sections of the rocks permitted the detailed microscopic examination of minerals and textures at up to 400X magnification in transmitted polarised light. The samples examined by Watchman were from unmodified cobbles collected by Hughes and Margrit Koettig from archaeological sites along Saltwater Creek. The sample examined by Geochempet Services was from a cobble collected by Hiscock and Hughes from the bed of the Hunter River near Carrington.

Two of the samples were a mixture of quartz and feldspar grains (including potassium feldspar) cemented by iron oxides, clays and silica. The presence of feldspar minerals may indicate these rocks were volcanic in origin; if so they could be tuff. However, there was nothing in the textural character of these two rocks as revealed in thin-sections that indicated they were tuffs rather than siltstones which contained some mineral content of volcanic origin. Therein lies the difficulty of ascribing a definitive name to a fine-grained rock in hand specimen when no distinguishing petrographic features exist at the macro- and microscopic scales. In the third sample the only recognisable

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Table 1 Lithological diversity diagnosed in Hunter Valley IMT through thin-section analysis.

Rock Type	Description	Tuff?	Analysed by
Siltstone	Angular clasts of quartz and plagioclase <0.1mm in diameter. Grains well-sorted but poorly-packed. Small % of rock is composed of wavy flakes of sericite, formed from potash feldspars and clay. Matrix consists of microcrystalline minerals, presumably a mixture of clay and silica.	Possibly	Watchman 1984
Ferruginised Sandy Siltstone	Consists of quartz, plagioclase and potash feldspar. Clasts generally angular, well-sorted, closely-packed and <0.2mm. Potash feldspar is partially altered to sericite. Cemented by sinuous iron oxides.	Possibly	Watchman 1984
Mudstone	Silts and fine sand clasts dispersed along thin distorted laminations. Clasts are essentially quartz and are angular, poorly-sorted and sparely-packed. Crypto-crystalline silica occurs as trace grains.	No	Watchman 1984
Chalcedonic Finely Silicified Mudstone	Uniform finely microcrystalline, broadly 'cherty', chalcedonic style silica with pervasive, slight limonitic iron oxide pigmentation with very fine porosity. The grain size of the chalcedonic silica is c.0.002-0.004mm: individual grains are barely discernable at 400X magnification. Most of the pores and the specks of limonitic iron oxide are as fine or finer, but there are sparse examples of scatter pores as large as 0.05mm. There is no suggestion of a tuffaceous precursor.	No	Geochempet Services 2000

minerals were quartz and crypto-crystalline silica and this sample is therefore not volcanic in origin. A fourth sample was a chalcedonic, finely silicified mudstone with no suggestions of a tuffaceous precursor.

Conclusions

Given the variability in gross mineralogical composition of these samples, we consider it appropriate to continue to use the term 'indurated mudstone' and inappropriate and inaccurate to interpret or label all specimens of this material as 'tuff'.

Certainly those who continue to use the term 'indurated mudstone' for this material from the upper Hunter Valley should state that some specimens of this rock may be volcanic in origin, in particular rhyolitic tuff. However, because of their fine-grained texture and the effects of lithification and metamorphism, it is not possible to classify individual samples of this rock precisely without petrological examination by methods such as thin-sectioning, x-ray diffraction or scanning electron microscopy. Only a few samples have been analysed so far and further systematic geochemical and petrological studies of samples of this rock type taken from known sources such as outcrops and river cobbles, and from stone artefact assemblages in the upper Hunter Valley are required to determine the range of lithologies it contains. Non-destructive analytical tools should provide confirmation of the volcanic origin for tuffs because of their distinctive geochemical signatures (e.g. Rb, Sr, K and rare earth elements) compared with volcaniclastic sediments containing mineral ingredients from mixed sources.

Nevertheless, those petrological analyses carried out to date show unambiguously that while some specimens have minerals in them of volcanic origin not all specimens are tuffs, and that even on the basis of thin-section analysis alone we have demonstrated that some specimens are not volcanic in origin. Archaeologists who persist in labelling this rock 'tuff' will be in the difficult position of needing to state that although they have called the category 'tuff' this class of rock contains other sedimentary lithologies, at least in the upper Hunter Valley.

For those who find the term 'indurated mudstone' unpalatable Corkill (1999) has provided a compromise solution. Faced with the problem of classifying similar raw materials in the Sydney region she adopted the term 'IMT', meaning 'indurated mudstone/tuff', as a label that both acknowledged the likely tuffaceous origin of some specimens but also recognised that the existing evidence logically prevents simply using the term 'tuff' to describe all specimens. Until much more is known about the range of lithologies represented in this rock type, and ways are developed to distinguish between them by hand inspection (a seemingly impossible goal in this context), the term 'IMT' ('indurated mudstone/tuff') is an acceptable alternative to the term 'mudstone' as a description for the fine-textured, very hard, yellowish, orange, reddish-brown or grey rocks from the upper Hunter Valley.

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