# 'Trent sand': chalcopyrite as an abrasive

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**Abstract**

A loose abrasive until recently used in silversmithing in the Jewellery Quarter of Birmingham has been identified as 'Trent sand'. Analysis showed that the chief component was chalcopyrite ($CuFeS_2$), an important ore mineral of copper. Problems of misinterpretation of the activities represented by abrasives and the need to record all the materials of traditional industries are discussed.

## Introduction

The Jewellery Quarter in Birmingham, England, is an enclave of traditional crafts surviving in the midst of one of the most highly industrialized cities in the modern world. Traditional metalsmithing continues to be practised in this Quarter, supporting a number of commercially successful firms. One of these, the St Dunstan Works of A Edward Jones Ltd, is still located in the Jewellery Quarter, on Pemberton Street. This firm manufactures domestic and ecclesiastical silver by traditional silversmithing methods.

During a visit to the St Dunstan Works sponsored by the Historical Metallurgy Society, an abrasive being used to polish silver attracted our attention because of its peculiar colour. It did not resemble any of the abrasives familiar from metallographic preparation. It had a grey-green colour that was too green to be silicon carbide and too grey to be chromic oxide. When asked to identify it, one of the craftsmen could only say that it was traditionally used, and that it was 'river sand', but not the river from which it came.

## Trent sand

During a recent interview one of the managers of A Edward Jones Ltd identified this abrasive as Trent sand. He had always thought this referred to the source being the River Trent, probably in the area of Nottingham. This was a likely supposition because the whole of the Trent Valley is an area much used for sand extraction. It could be considered one vast sandpit, as extraction takes place along the whole length of the River and its tributaries.

The rock source of Trent sand also is not known. Had it been dredged, then the sand could have had its origin very far upstream from the dredged location. Until recently the rivers local to Birmingham, which feed into the Trent, flooded nearly every winter and there were no sediment traps on them. Even now, with a few worked out gravel pits being used as traps, the winter flow through the narrower areas of the valley moves large quantities of sand with it, depositing the sand where the river widens out. There is virtually no navigation by deep draughted boats up to Nottingham nowadays, so dredging for navigation also has ceased. Some dredging for industrial sand still takes place on the rivers near York but this is not thought to be related.

The art metalwork trade has outlawed the use of Trent sand since about 1985 because it is claimed to be a health hazard. The ban on its use is a voluntary one, not statutory, although the Health and Safety Executive is aware of Trent sand, and the product is no longer available. The problem arises from the silicon it contains and the silicosis that may result from inhaling it. Instructions for use in the sanding of nickel silver cutlery and tableware reported (Canning 1960) that 'This process involved the use of Trent sand damped with a little resin oil. During sanding the article was turned in the hand and held against the bob in a series of short strokes. Meanwhile finely sieved Trent sand damped with resin oil was gathered by the polisher in the right hand and allowed to fall between the article and the bob ...'. Earlier (Canning 1901), Trent sand was described as '... usually supplied to the user sieved and prepared for use. It is damped with a good quality mineral oil to prevent it from flying about'.

Many of the principal users of Trent sand are no longer in business and others, like Barker Ellis, have acquired new owners and new staff; nevertheless the existing trade points to W Canning & Co Ltd of Birmingham as the supplier. They claim, however, to have been only factors, and their Operations Manager after making inquiries on our behalf had no definitive identification of its source. Canning has new owners and unfortunately for our purposes they have not maintained extensive archives. However, they are certain it came from the River Trent area, possibly from a company called Trent Sand Ltd though the available directories for Nottingham do not record such a firm. Further enquiries among former directors of the Canning concern elicited no more information.

There is a reference to Trent sand in the official history of this firm, *The Canning Story 1785-1985* by David

Thomas (1985). Ernest Canning recalled on one occasion the dreadful machine – the 'contraption' he called it – for sieving sand from the River Trent but here again the exact location of its source was not documented. In the absence of documents only memory and recollection remained to be consulted. An elderly acquaintance who was a boatman on the Trent for most of his working life (Mr Isaac Argent, personal communication 6 June 1994) suggested the Newark area, and further enquiries were made there. The official reply from British Waterways, who now manage the River Trent, was that the sand was dredged from just below Cromwell Lock, five miles downstream from Newark on the tidal section, transported a mile farther downstream to Teal's Wharf at Carlton, and then by road and rail to Birmingham (Fig 1).

To locate the geological origins of this secondary deposit would be difficult. Given the number of tributaries to the River and the ebb and flow along this stretch of it, the mineralogical composition of the sand as dredged may well have varied from time to time. The consistency of Trent sand as a commercial product may have resulted from dredging only at specific seasons and subsequent processing; however, we have no information that such procedures were required.

## Colour

A sample of this abrasive was examined at the Conservation Analytical Laboratory of the Smithsonian Institution. To determine the colour a small lump was wet with water and spread out on thin, white card to dry, then compared with two sets of Munsell cards (Munsell 1915, Munsell 1975). The colour measured in the Munsell Colour System is 5Y4/1.

## Polish

A comparison of the polish obtained with this abrasive on silver with a standard metallographic polishing abrasive was made on coin silver, an alloy of silver with copper. One surface of a 1943 United States silver dime was prepared by being finely polished with a sequence of abrasives down to gamma alumina (0.05$\mu$m particle size). Half of this surface was abraded with 600 grit (*c* 14$\mu$m particle size) silicon carbide, the other with Trent sand. The appearance of the polished surfaces at a magnification of 25× can be compared in Figure 2.

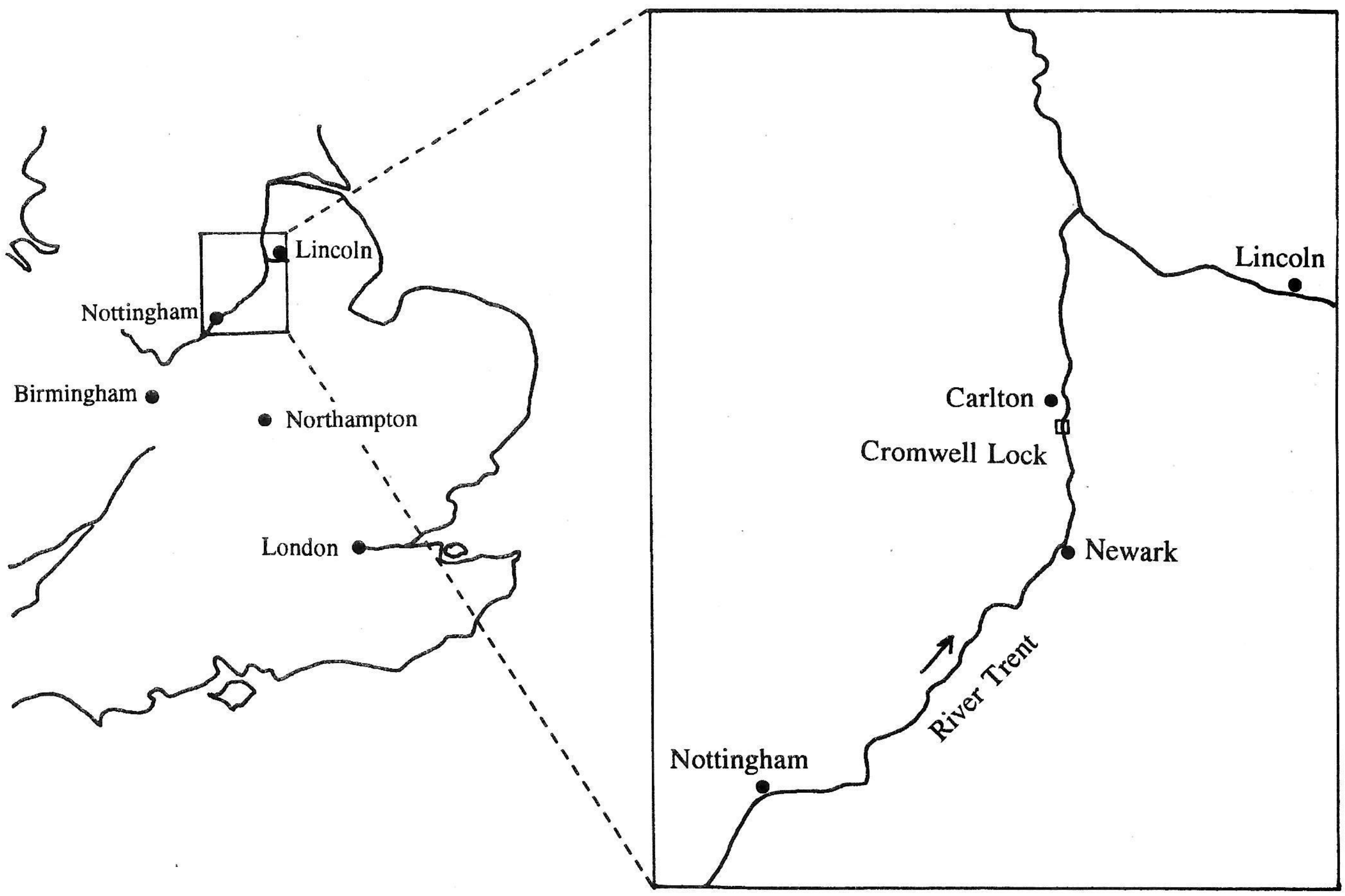


*Figure 1: Map, showing likely source of Trent sand.*

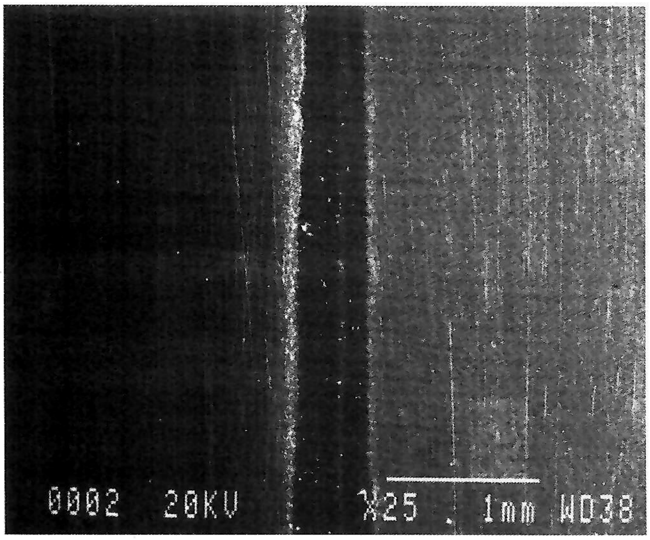


*Figure 2: Polished coin silver abraded with (left) Trent sand, and (right) 600-grit silicon carbide.*

## Microscopy

The maximum particle size of the sample, measured by optical microscopy, was 0.22mm. Scanning electron micrographs show (Fig 3) the abrasive at 2200×, and a large particle selected for single-particle analysis (Fig 4); many smaller particles and the occasional cotton fibre from the polishing wheel were also observed in our sample.

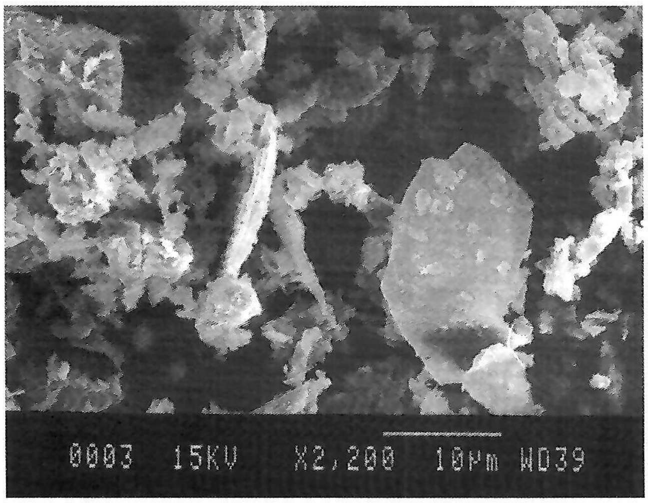


*Figure 3: Scanning electron micrograph of Trent sand (×2200).*

## Analysis and identification

The energy dispersive X-ray spectrum of the abrasive shows energy peaks for S, Fe, and Cu; also Si, Al, Mg, and Ca (Fig 5). The spectrum was flat beyond 10 keV where the principal energy peaks for lead occur, therefore no lead was detected, and so the S Kα peak was not confused with the Pb Mα peak that can occur at the same energy. The spectrum of the single large particle is shown in Figure 6, where the S, Fe, and Cu peaks are even more prominent.

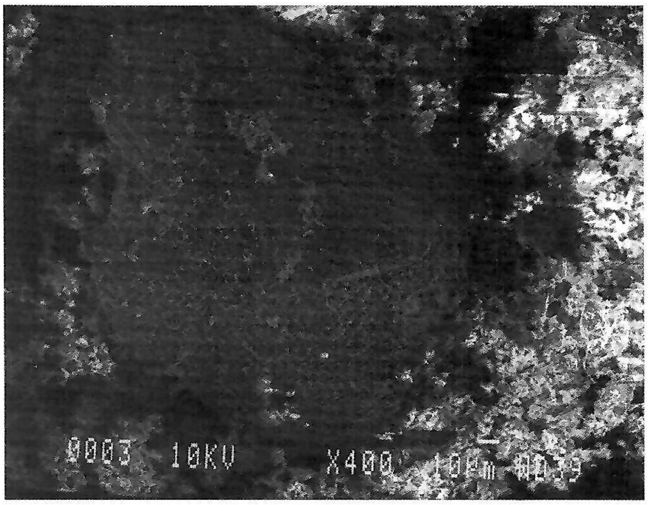


*Figure 4: Scanning electron micrograph of the single particle (×400) analysed in the spectrum of Figure 6.*

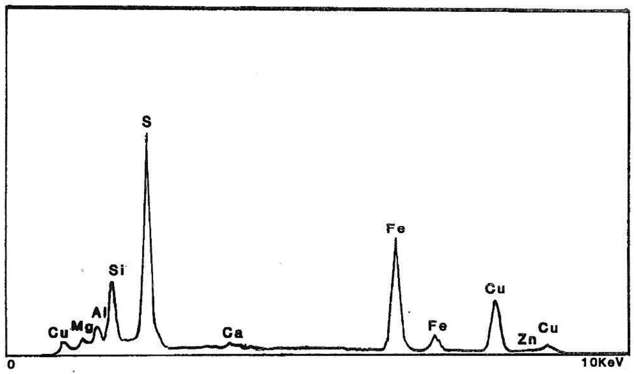


*Figure 5: Energy-dispersive X-ray spectrum of Trent sand.*

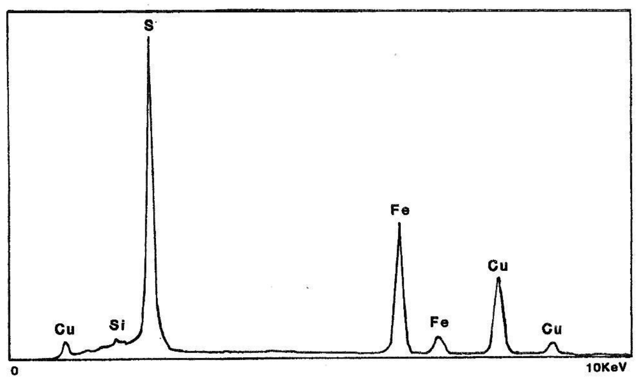


*Figure 6: Energy-dispersive X-ray spectrum of the single particle of Trent sand shown in Figure 4.*

X-ray diffraction of the sample was used to identify the specific minerals present. The major component is the mineral chalcopyrite, which has the formula $CuFeS_2$ (Table 1). A small amount of synthetic silicon carbide was detected also, as well as quartz and other minerals.

| Measured | Reported | Reported intensity |
|---|---|---|
| | Chalcopyrite ($CuFeS_2$) | |
| 3.0354 | 3.038 | 100 |
| 1.8546 | 1.8570 | 37 |
| 1.8692 | 1.8697 | 22 |
| 1.5920 | 1.5927 | 27 |
| 1.5791 | 1.5753 | 14 |
| | Quartz ($SiO_2$) | |
| 3.3322 | 3.342 | 100 |
| 1.8154 | 1.8179 | 14 |
| 2.2767 | 2.282 | 8 |
| | Synthetic silicon (Si) | |
| 3.1259 | 3.1355 | 100 |
| 1.9121 | 1.920 | 60 |
| 1.9144 | 1.9201 | 53 |
| 1.6332 | 1.638 | 35 |
| 1.6324 | 1.6375 | 30 |

*Table 1: X-ray diffraction results, with the measured d-spacings of Trent sand in order of estimated intensity.*

The Mohs' hardness of chalcopyrite lies between 3½ and 4, on a scale where calcite is 3 and fluorite is 4, well below that of quartz, which is defined as 7, and at least twice as hard as silver.

**Discussion**

In the study of ancient and traditional crafts attention is naturally drawn to the objects produced, and to the craftsman and his tools. Little attention is ever given the supplies of disposable materials such as abrasives that may be used. Abrasives that are reported are generally in the form of stones. Tucker (1983) has written a monograph on Ayrshire hone stones, and there also exists an interesting report on the use of natural corundum in hones manufactured for the natural rubber industry in World War II (Oates and Harris 1948).

Abrasives reported from archaeological excavation are chiefly touchstones (Eluère 1986, Oddy 1986) and some whetstones. Though a few touchstones are described as grey-green (Moore and Oddy 1986), none have been identified as chalcopyrite. This is to our knowledge the first report of chalcopyrite as an abrasive powder.

Chalcopyrite is well known as an important ore of copper. Our finding presents a warning when interpreting ore minerals in finely particulate form, especially when other evidence of grinding (as in ore preparation) is present: the powder may not have resulted from preparing ore for smelting but be a part of a finishing operation instead.

A Japanese document circa 700AD on a hand scroll in the Shosoin Treasury specifies the grit sizes needed to polish metal mirrors to be presented to the Great Buddha of Todai-ji (Nakano 1967). The abrasive materials mentioned include grit from limestone, soft charcoal, rough charcoal, blue whetstone, and iron powder resulting from blacksmithing (Anne Yonemura 1991). This last abrasive is iron scale, the mineral magnetite, another mineral easily misinterpreted as an indicator of smithing or even smelting rather than polishing.

**Conclusions**

It seems that Trent sand went out of use as an abrasive shortly after the sample reported on here was collected in 1984. This experience points up the urgency of recording traditional crafts and collecting their materials in a comprehensive and timely manner. It also illustrates that the need to do this is not limited to the so-called Third World but exists in industrial societies as well.

Specifically it draws attention to abrasives and the need to:
1) characterize abrasives presently being used in traditional industries, wherever these are located;
2) identify the abrasives mentioned in documentary sources; and
3) look for abrasives at workshop sites, especially where they are likely to be mis-identified as the detritus of other operations.

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