

Micro-XRF Study of Buzzard Coulee Meteorite

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Summary

A 35 mm square slice of Buzzard Coulee meteorite was cut with a wire-saw and polished. The brecciated structure of the meteorite is evident, especially in the silicate matrix. The slice was further examined using a micro-XRF. Approximately 1 million spots in five images were mosaiced to give an overall resolution of 40 micrometres per pixel. 8-bit grey scales images were produced for many major and minor elements, however, the system is not very sensitive for elements lighter than magnesium. Elemental maps were adjusted for contrast and then assembled into three-colour composite images for further interpretation. The overall composition was kamacite = 10.9%; taenite = 0.23%; troilite = 3.7% with the remainder dominated by silicates. Maps of Cr, Cu, P and Ca reveal the presence of sparse grains of chromite, chalcopyrite and Ca-phosphate (merrillite?). Mineral distribution was heterogeneous throughout the slice and conformed to some extent to the fragments identified in the scanned image. The distribution of sulphides is particularly interesting and may reveal other fragments. In one part of the slice a foliation is clearly visible, revealed both by the orientation of flattened chondrules and metal grains. Adjoining chondrules are indented suggesting pressure solution during compaction. Hence, there seems to be evidence of deformation during lithification, a normal process on earth but perhaps less expected on an asteroid.

Introduction



Over 1000 fragments of Buzzard Coulee fell in Saskatchewan on 20 November 2008. The meteorite is a H4 ordinary chondrite, with shock stage S3. The fragment examined here was cut with a wire saw at the Royal Ontario Museum from an 85 g individual specimen provided by Murray Paulson. The specimen was selected because of the presence of visible veins on the broken surfaces (Figure 1). The slice studied is about 2 mm thick and 35 mm square. Both surfaces of the slice were polished to remove saw marks.

Figure 1: Photograph of the Buzzard Coulee specimen, showing the approximate location of the slice. Veins are denoted by the red arrows.

Petrography

The slice was initially imaged in reflected light using a document scanner (figure 2). Four fragments were outlined from the image and confirmed using a stereo microscope. One criterion was the presence or absence of dark, fine-grained minerals between the chondrules. There are undoubtedly other, smaller fragments.

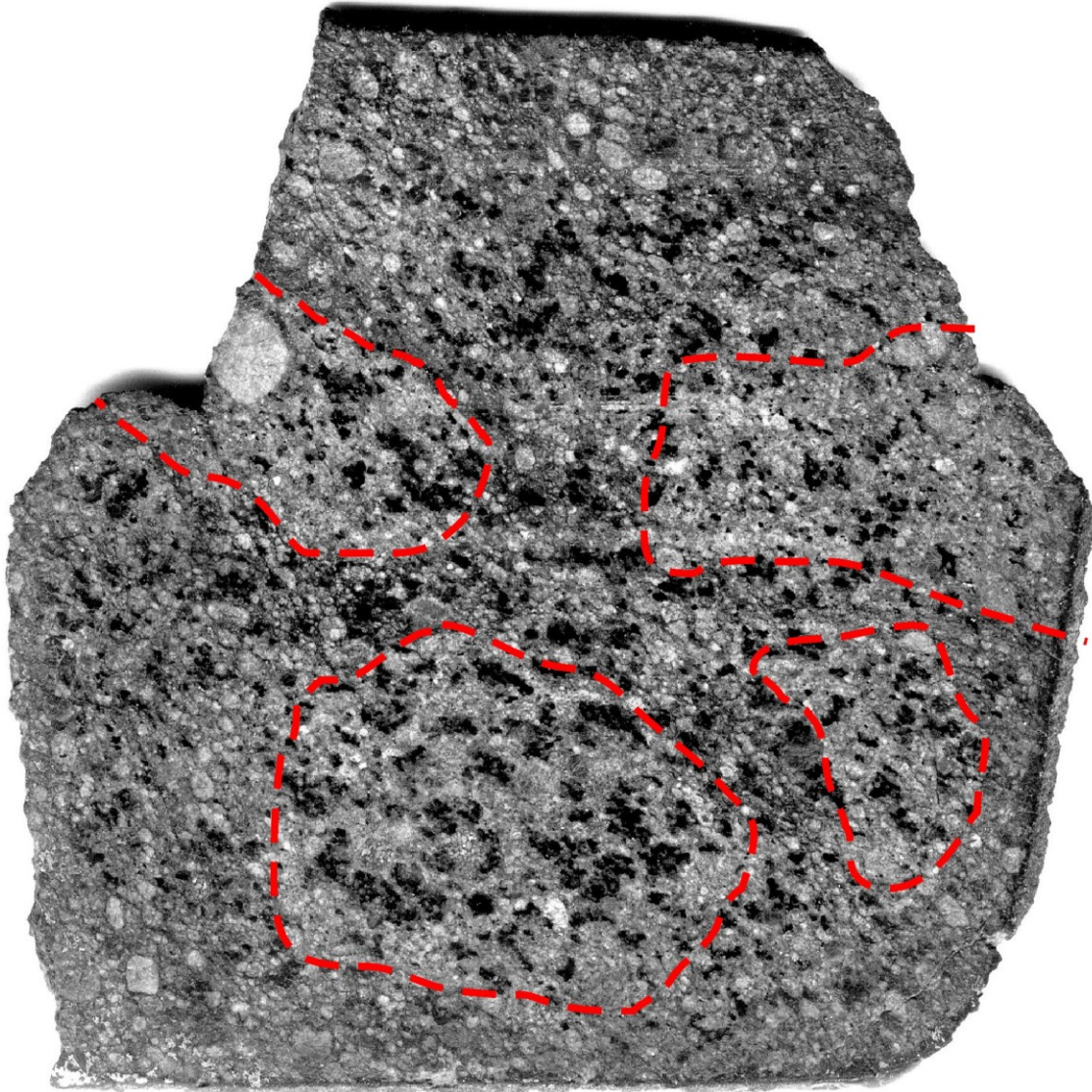


Figure 2: Reflected light image of a slice of the Buzzard Coulee meteorite 35 mm square. The image was produced using a document scanner. Metal appears black as the light source and detector are not orthogonal to the surface. Lack of black areas (metal) near the edges is an artifact of the scanner. Fragments are outlined in red.

Chondrules in the upper part of the slice show a well-developed fabric. Chondrules are flattened and appear to have been impressed on each other. The fabric is also evident in the shapes of the metal fragments. Other parts of the slice also have a fabric, but it is less well developed.

The slice was further examined using an Eagle III micro-XRF. Approximately 1 million spots in five images were mosaiced to give an overall resolution of 40 micrometres per pixel. 8-bit grey scales images were produced for many major and minor elements, however, the system is not

very sensitive for elements lighter than magnesium. Elemental maps were adjusted for contrast and then assembled into three-colour composite images for further interpretation.

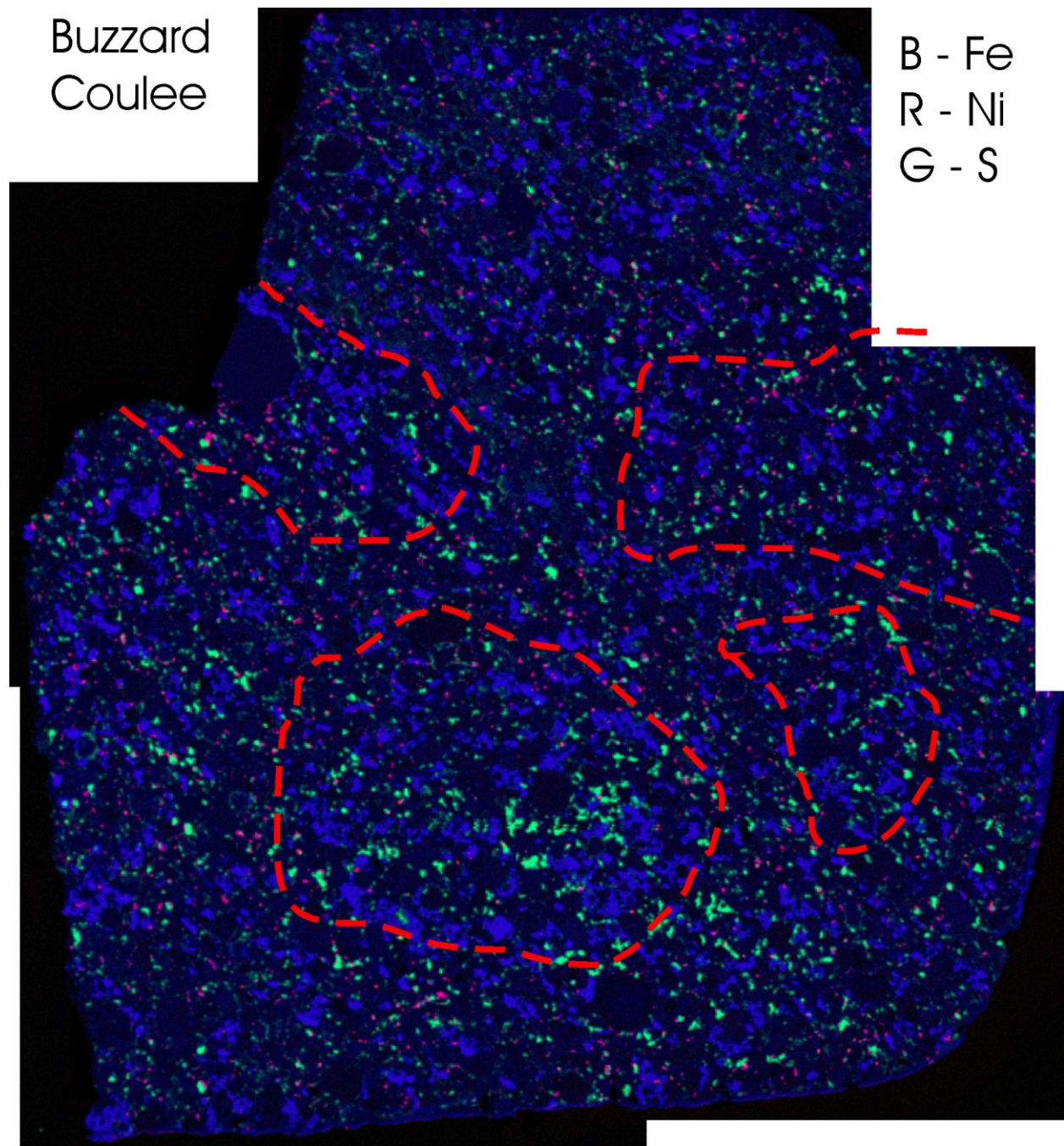


Figure 3: Micro-XRF image for Buzzard Coulee. 35 mm width of image. Blue = Fe; Green = S; Red = Ni. Fragments identified in the scanned image have been outlined in red.

The overall mineralogical composition was determined from the elemental maps. Kamacite = 10.9%; taenite = 0.23%; troilite = 3.7% with the remainder dominated by silicates. Maps of Cr, Cu, P and Ca reveal the presence of sparse grains of chromite, chalcopyrite and Ca-phosphate (merrillite?).

Mineral distribution was heterogeneous throughout the slice and conformed to some extent to the fragments identified in the scanned image. The distribution of sulphides is particularly interesting and may reveal other fragments. Ultimately we hope to be able to determine the

overall composition of different fragments and hence establish the chemical variation in the original parent object.

Conclusions

Buzzard Coulee is clearly a breccia. Compositional differences are present between the fragments, especially in the sulphide content. The degree of foliation in some parts of the meteorite was surprising. This points to deformation during lithification, a normal process on earth but perhaps less expected on an asteroid.

Acknowledgements

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