Short Note on the Neereno Hill Impact Breccias

(Working Draft)

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Summary

The Neereno Hill breccias are located between the towns of Perenjori and Three Springs in WA's Midwest district. They have been described by Lipple (1982) to have produced by debris flow down steep topography on the Archaean basement of the Yilgarn craton. A literature study and examination of outcrops in the area by the author indicate these breccias may have been produced by a meteorite impact.

Outcrops have been identified in the field to be possible lithic breccia, impact melts and pseudotachylite veins, with possible shatter cones seen in one sample.

Further work is required to better understand the nature and distribution of these rocks, but preliminary results indicate a central uplift of brecciated Archaean basement rocks with pseudotachylites, surrounded by impact breccias possibly formed by flow back into the excavated crater.

The age of the impact is greater than 1200 Ma based on the occurrence of numerous cross cutting mafic dykes which are probably part of the Marnda Moorn large igneous province. This would make this impact structure Mesoproterozoic in age or earlier.

Introduction

The author has been examining the geology of Western Australia looking for rocks and/or breccia zones that are seemingly out of character to their geological environment, which may represent impact structure deposits or events. The Neereno Hill breccias are a good example of the early results of this study. Other areas in Western Australia have been identified but time has not permitted any follow-up work to date in these other areas.

The author is a professional geologist with over 40 years of experience in exploration and mining, principally in the search for diamonds, nickel, iron ore and copper. The author is a fellow of the Australasian Institute of Geoscientists and a member of the Geological Society of Australia and the Meteoritical Society.

The sedimentary breccias of the Neereno Hill area were first described by Lipple (1984) and are included in the Proterozoic age Billeranga Subgroup of the Moora Group (Baxter and Lipple 1985). The Moora Group is a thin remnant of a formerly extensive platform sequence which unconformably overlies an irregular Archaean basement topography. The sequence comprises a weakly deformed, immature fluvial – alluvial fan – basin margin lower part with a significant volcanic or volcanogenic component (the Billeranga Subgroup); and an undeformed, disconformably overlying mature, upward-fining, siliciclastic-dolomitic, paralic upper part (the Coomberdale Subgroup) (Baxter and Lipple 1985).

Lipple (1984) described the sedimentary breccia to have been formed by mass transport in rock avalanches and debris flows from adjacent hilly terrain. The author's view is that the breccias are the result of an impact event and are impactites.

The age of the Moora Group is estimated as mid-Proterozoic based on an imprecise radiometric age date (Compston and Arriens 1968) of 1000 my for the Morawa Lavas (Billeranga Subgroup) in the Billeranga Hills.

Previous Work

The most comprehensive description of the sedimentary breccia has been done by Lipple (1984) during his mapping of the Perenjori 1:250 000 map sheet and his work is is summarised below. Figure 1 show the detailed mapping undertaken by Lipple.

Lipple (1984) stated that the abrupt lateral and vertical facies make it difficult to interpret. He records a change in character southwestwards from sandy, framework breccia and sandstone (best developed at Neereno Hill), through megabreccia (dominant at Hebiton-Kinyorra farm), and conglomeratic mudstone (Kinyorra), to graded, interbedded breccia, sandstone, wacke and shale (Kinyorra-Breakaway Hill).

The megabreccias are unsorted, thick-bedded to massive rocks with angular clasts of feldspathic gneiss irregularly distributed forming a close-packed, anisotropic framework. Lipple described three major types for mapping purposes;

1. Matrix poor (about 2%) megabreccia with clasts predominantly greater than 5 cm (commonly 50-200 mm) maximum dimensions,

2. Matrix poor (about 2%) breccia with clasts mostly 2-10 cm maximum dimension, and,

3. A framework breccia (about 20% sandy matrix).

Megabreccia is the dominant type, with types 2 and 3 occurring mostly in an area 500 – 2000 m west southwest of Kinyorra (Carramar) homestead. Where the breccia overlies mudstone or siltstone, there are flame structures along the base, and slump folding in the bedded siltstone appears most intense adjacent to breccia margins. Megabreccia also directly overlies the Archaean basement rocks. Neptunian dykes of breccia fill crevices in the basement. A characteristic red or purple oxidation colour is present in most of the breccia and megabreccia and in basement rocks adjacent to joints.

Clasts are very angular, with elongate to equant shapes and numerous planar faces derived from joints and foliation in the source rock. The clast types can be directly traced to the adjoining basement with felspathic orthogneiss dominant. A few amphibolite, dolerite, semipelitic paragneiss, ultramafic schist and metaperidotite were noted. The size distribution of clasts appears to be polymodal and skewed towards the coarse end of the range. Clasts range from less than 1 mm up to 8 x 3 m and 5 x 7 m dimensions in pavement outcrops. In the mega breccia, blocks exceeding 1 x 1 m in size are common. Most clasts have face, rather than point to edge contacts. Planar to indented contacts (concavo-convex) to weakly sutured, up to 2 m long with little or no intervening groundmass are common.

Some clasts are partially crushed to a mosaic of subgrains in a braided fracture pattern. In megabreccia, thin dykes (up to 1 m long and 3 cm wide) of mudstone between clasts indicate hydroplastic flow. In a few places (e.g. Hebiton farm) distinct beds of megabreccia and breccia up to 10 m thick are separated by less than 20 cm of lithic sandstone or immature, weakly bedded, graded sandstone.

Field Visit

The outcrops in the Carramar (Hebiton) and Kinyorra farm areas were visited briefly by the author in July 2015 to examine the outcrops for possible impact features. The paper by Lipple (1984) was used as the base for these initial investigations. His map and geological codes are shown in figures 1 and 2.

The farm owners were contacted for permission to visit the areas and their contact details are shown below.

Examination of the megabreccia outcrops confirmed the observations by Lipple of the breccias. The nature of the breccia were very reminiscent to the author of images seen of pseudotachylite and impact breccias from the Vredefort impact structure in South Africa, and outcrops of the Sudbury Breccia seen by the author during a visit to the Sudbury impact structure.

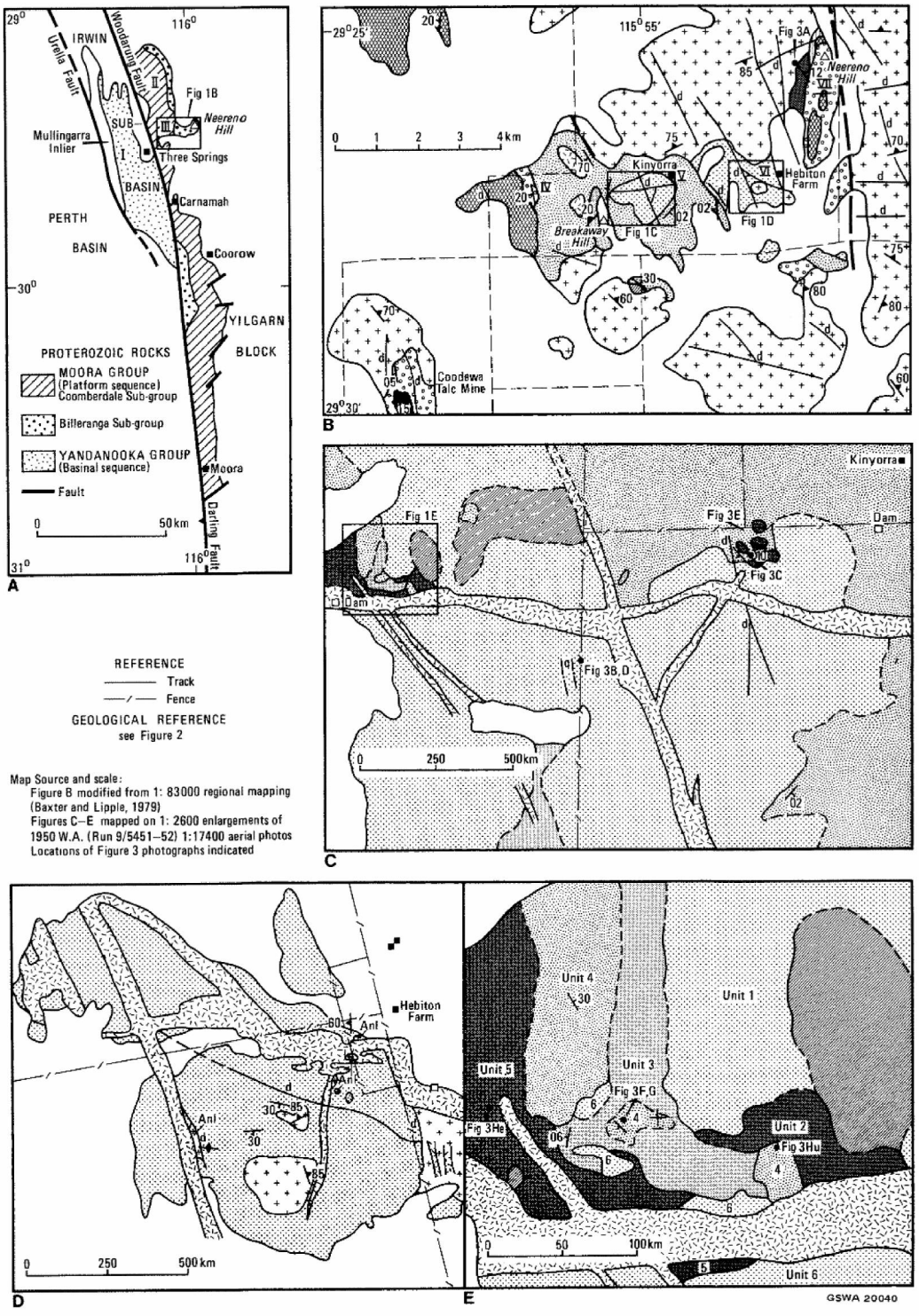

Figure 1. Geological Map from Lipple (1984)

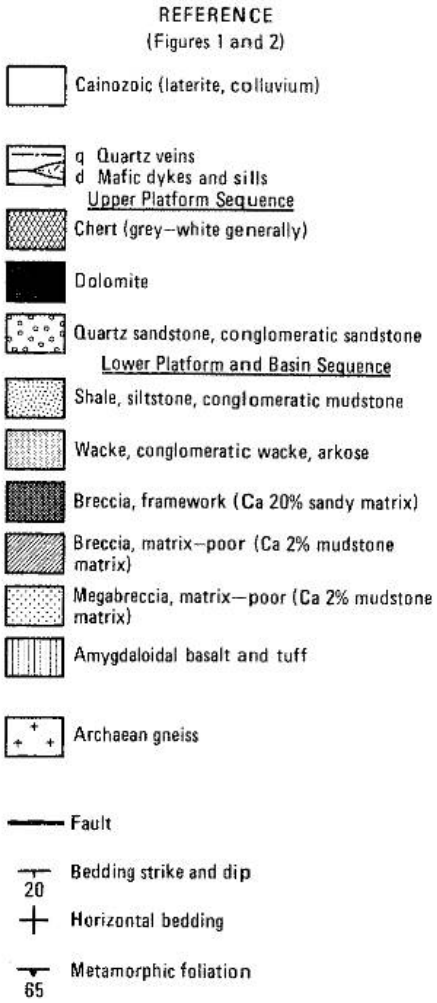

Figure 2. Geological legend for the geological map in figure 1 (from Lipple 1984).

Two areas were visited; one to the west of Carramar homestead and the second to the west of the Kinyorra homestead.

The coarse and angular nature of the breccia is striking and not a breccia that would normally be associated with fluvial processes. The common occurrence of a very dark grey fine grained matrix to the breccia containing entrained angular clasts is very similar to images of pseudotachylites and melt rocks from the Vredefort impact structure in South Africa, and outcrops of the Sudbury Breccia seen by the author in Sudbury Canada.

Figure 3. View from Bateman Road looking north towards the Carramar area. The breccias are located in the bush areas along the top of the hills.

Figure 4. Typical rubbly outcrop of the lithic breccias, locality GB17, Kinyorra area.

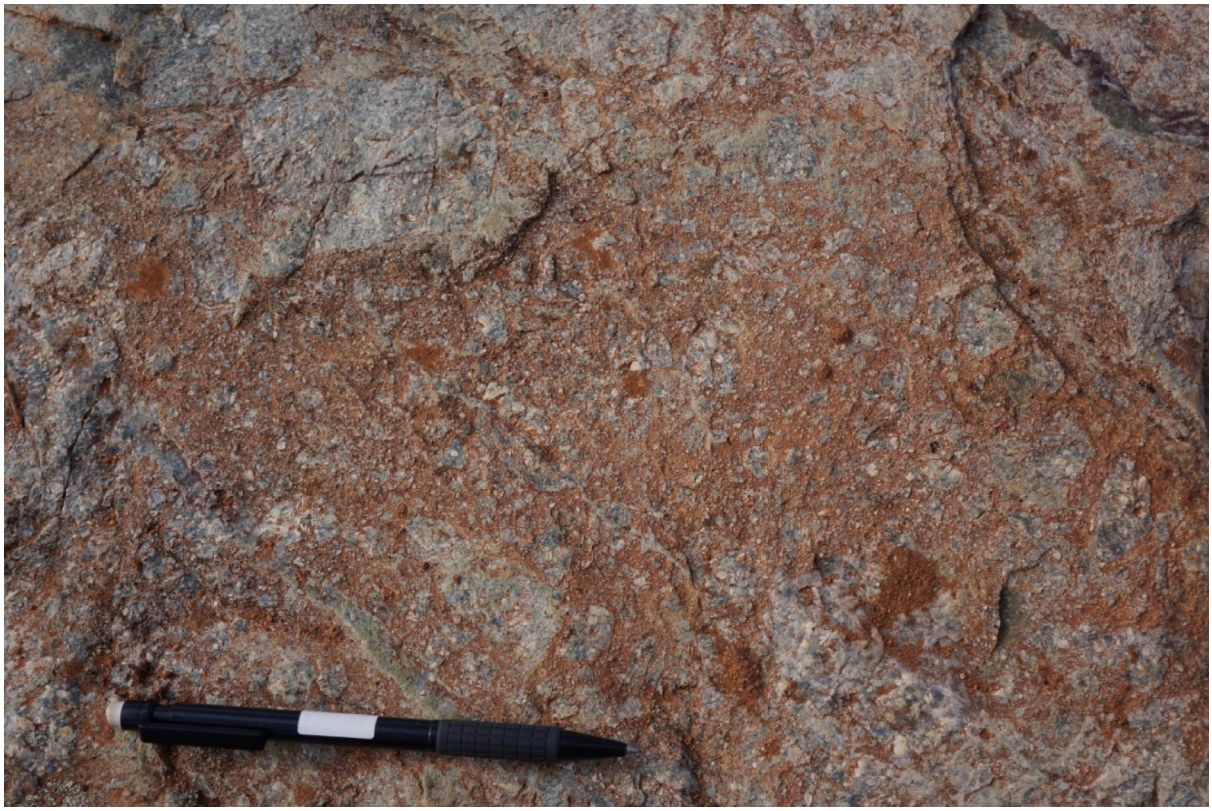

Figure 5. Relatively fine grained lthic breccia, locality GB15, Carramar area.

Figure 6. “Medium” grained lithic breccia, locality GB24, Kinyorra area.

Figure 7. Typical lithic megabreccia, locality GB20, Kinyorra area.

Figure 8. Possible pseudotachylite vein in breccia, locality GB07, Carramar area.

Figure 9. Possible pseudotachylite between granitic clasts, locality GB08, Carramar area.

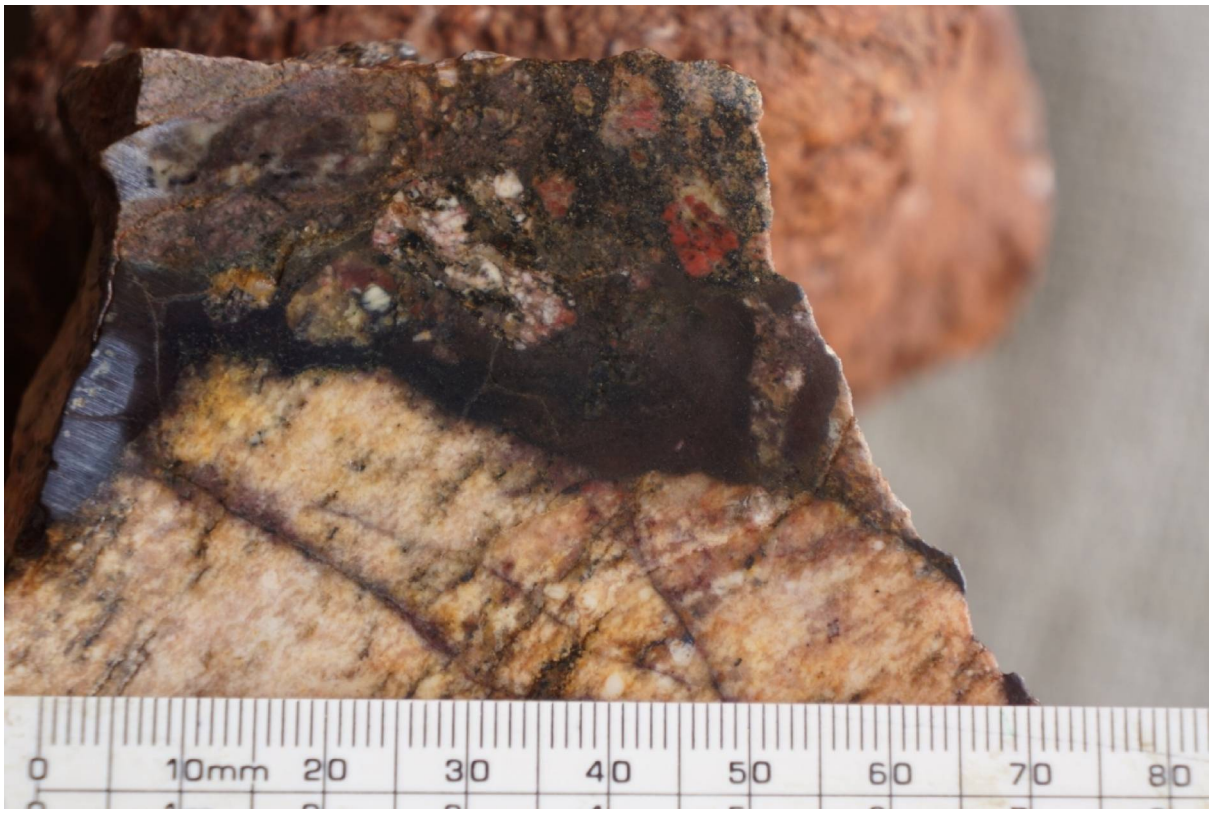

Figure 10. Sawn slab from locality GB08 showing fine grained possible pseudotachylite between clasts.

Figure 11. Possible impact breccia with angular clasts, locality GB05, Carramar area.

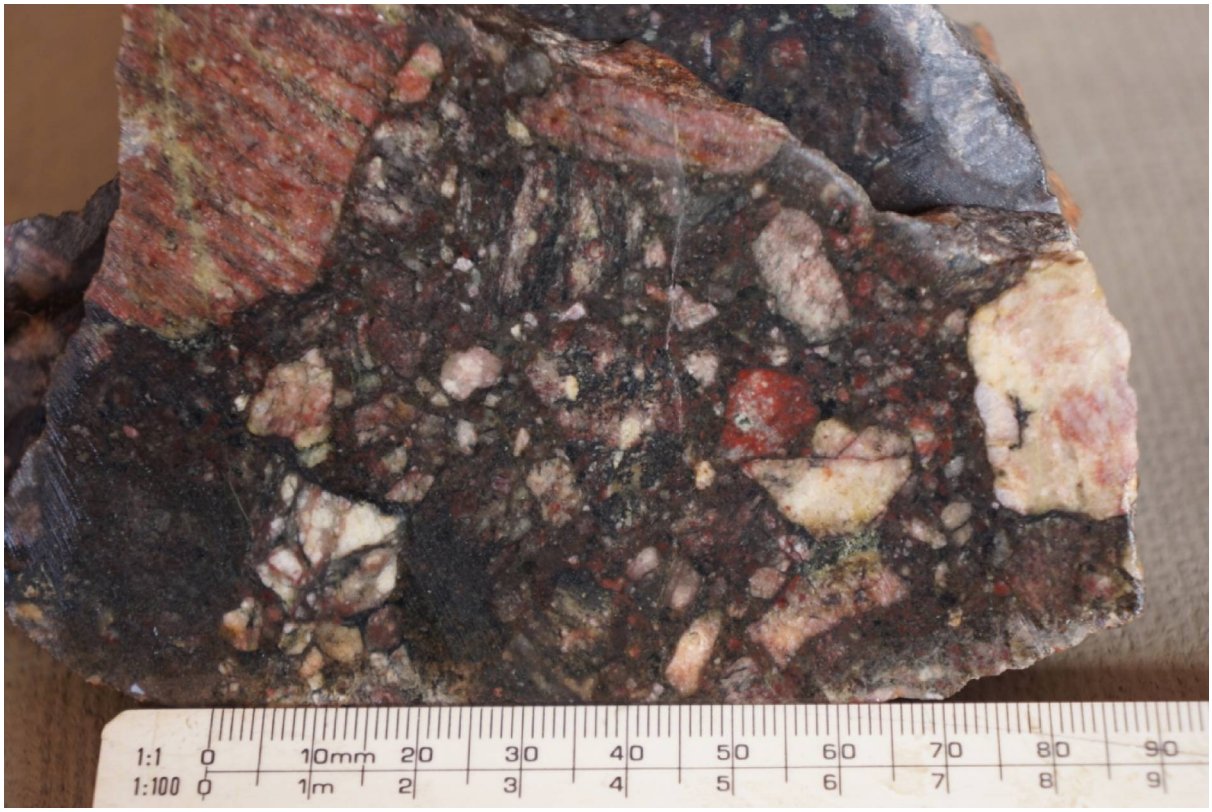

Figure 12. Sawn slab of possible impact breccia from locality GB10.

Figure 13. Possible pseudotachylite zone with entrained granitic gneiss clasts, locality GB27, Kinyorra area.

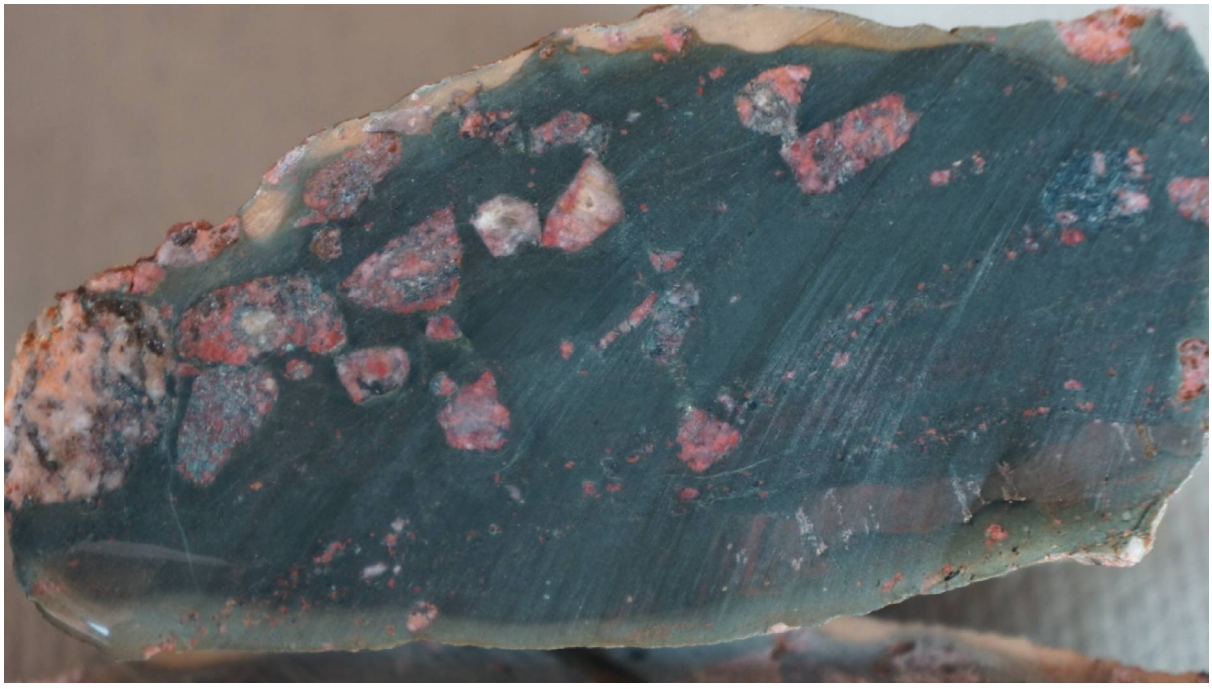

Figure 14. Possible impact melt with entrained granitic clasts from locality GB16. Width of specimen 6 cm.

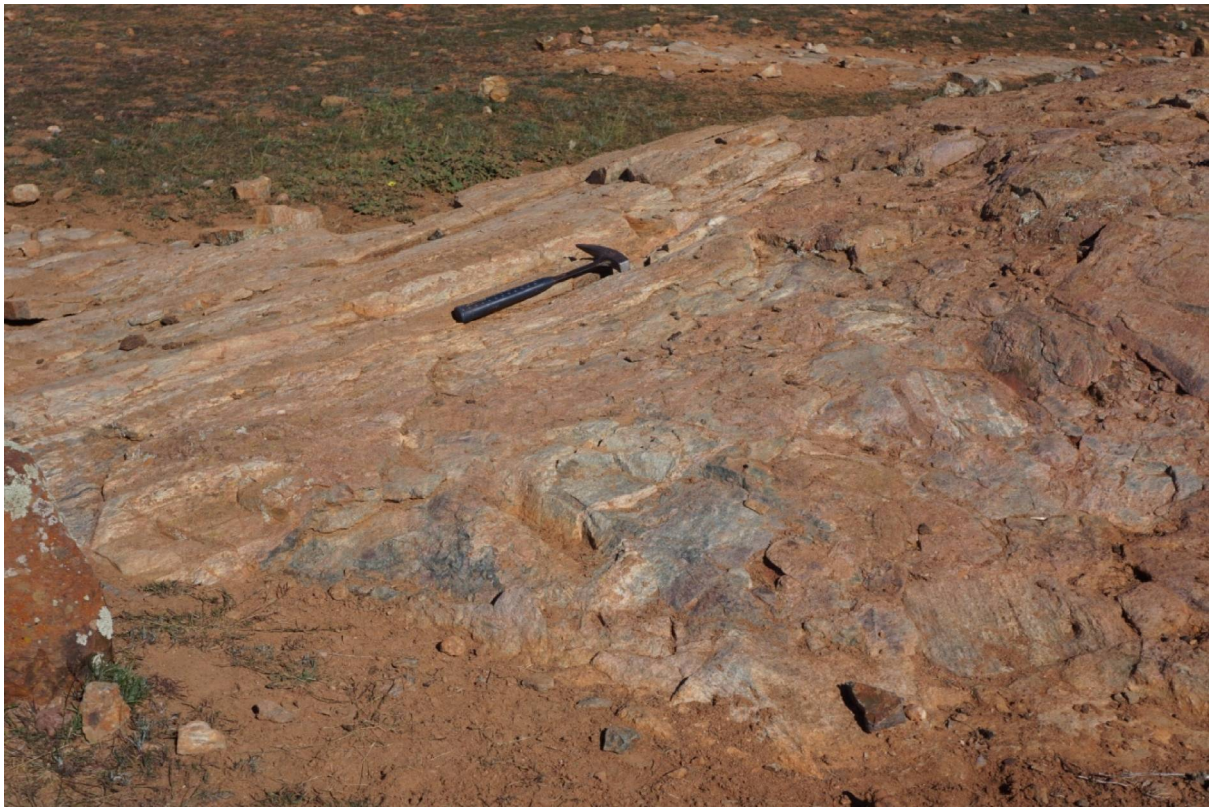

Figure 15. Bedded sandstone (under hammer) overlying megabreccia, locality GB18, Kinyorra area.

Figure 16. Possible shatter cones on the surface of a granitic gneiss clast, locality GB02.

Discussion

The breccias exposed in the Carramar and Kinyorra areas are polymict, containing a variety of granitic and metamorphic rocks, with a matrix of either a dark coloured fine grained matrix or a matrix of more sandy sized materials. Proterozoic sedimentary clasts appear absent. All rocks are silicified and very competent. The clasts vary in size to about 8 m with the majority in the range of 10 to 50 cm. The clasts are angular to subrounded with the majority being angular.

In hand specimen, the dark matrix to the clasts appears to resemble a pseudotachylite-like material. Sawn slabs of this material indicate fractured clasts at all scales.

The lack of Proterozoic sedimentary clasts may be a function of lack of preservation due to the energy of the impact, or that the impact occurred prior to the deposition of the Proterozoic sediments.

The nature of the breccias and related sediments indicate that these breccias may have been produced by a meteorite impact. The breccias would be best described as lithic breccias (Stoffler and Grieve, 2007) and probably formed part of the crater infill.

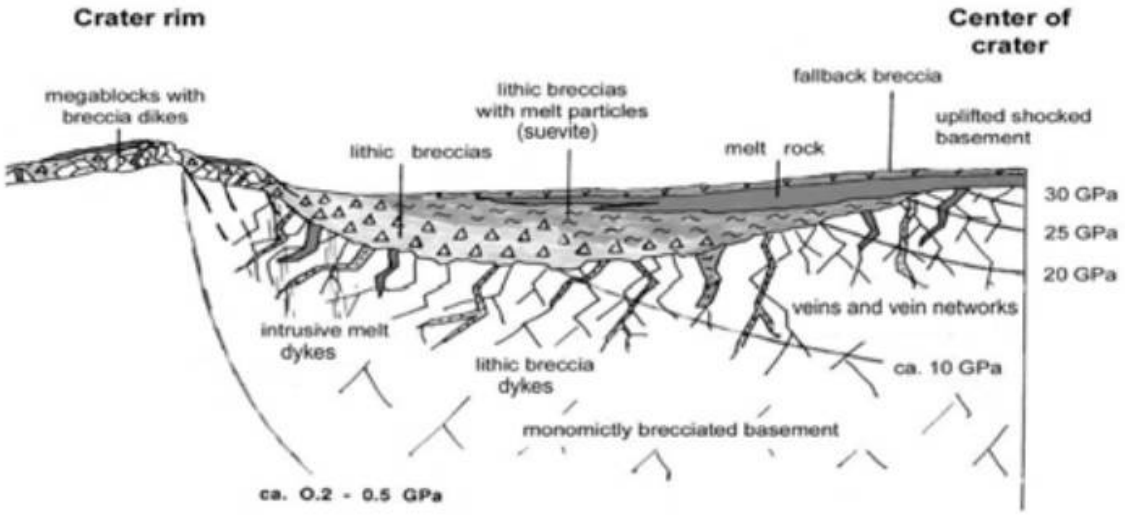

Figure 17. Distribution of impactites in an impact crater (Stoffler and Grieve 2007)

The lithic breccias in the Kinyorra area appear to be overlain by Proterozoic sediments but more field work is required to obtain further field evidence of the relationship between the breccias and the Proterozoic sediments.

The pattern of outcrop would indicate a possible crater infill unit. Lipple (1984) describes the breccia interbedded with sandstones which may represent possible fluviatile crater infill. The author has not examined these rocks to date. Lipple also describes a change from Neereno Hill (in the north east of the area) where the breccia are interbedded with sandstone, towards the south west in the Carramar area where they are predominantly

breccia, and then further southwest the breccia are again interbedded with sediment. This variation may represent the exhumation of various parts of a crater.

The geology of the Billeranga Subgroup indicates a shallow marine environment and therefore any impact at that time would have excavated a crater in the sediments, with the impact potentially creating a central uplift, now possibly represented by the granitic breccias and pseudotachylites of the Carramar area. Flooding of the crater post-impact would have mixed impactites with the surrounding sediments and inflow back into the crater allowing mixing of the impactites and sediments which are described by Lipple from the adjacent Neereno Hill and west of the Kinyorra farm areas.

Mafic dykes cut the breccia rocks and are these dykes are probably part of the Marnda Moorn igneous event which has been dated at about 1210 Ma (Wang et al 2014) and therefore gives a minimum age of 1200 Ma for the breccias. The Marnda Moorn igneous province occurs over a large part of the Yilgarn craton with NNW dyke trends in the western part of the Yilgarn in the area of the Moora Group exposures. Dyke swarms of other ages have east-west or northeasterly dyke orientations. The dykes are medium grained dolerites with wide chilled margins but may be too altered to obtain an age date (Mike Wingate, pers. Comm., 2015).

Attached Maps

Map 1 shows the location of the Neereno Hill breccia (cross hatched area) mapped as Billeranga Subgroup in the Geoscience Australia 1:250 000 vector geology of Western Australia. The black dashed line illustrates the possible extent of impact effects and the red dashed circle is a circular magnetic feature that may or may not be related. There is a distinct change in drainage character within this red circle which may indicate a change in rock type.

Map 2 shows the local geology from the GSWA Perenjori 1:250 000 map sheet. Map 3 is the total magnetic intensity image from the Perenjori magnetic survey and map 4 is the regional gravity data enhanced for the area.

Planned Future Work

Four samples have been send for thin section preparation from localities GB08 (possible pseudotachylite), GB10 (possible impact breccia) and GB16 (possible impact melt). The next field trip is planned for early September 2015 and is aimed at examining the relationships between the breccia and the Proterozoic sediments.

Enquiries have also been made to Curtin and UWA about possible research projects for the Neereno Hill breccias.

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