SANDFIRE RESOURCES NL

Borroloola Exploration

GEOLOGY OF NORTH COSTELLO PROSPECT

SEL 26837

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EXECUTIVE SUMMARY

The Costello Range in the vicinity of the North Costello QuestEM airborne-detected conductivity anomaly exposes a generally northeast to east facing and dipping sequence of the lower members of the Tawallah Group, from the top of the Yiyintyi Sandstone to the Aquarium Formation. In the southeastern sector, northeasterly dipping Masterton Sandstone and Mallapunyah Formation of the lower McArthur Group overlie the Tawallah Group, probably with slight (but obscured) unconformity. Most of the conductive zone is covered by Cainozoic alluvium. Lithofacies data from Sandfire's 2011 reverse circulation drilling program, regrettably limited by deep weathering, suggests that bedrock beneath the anomalous zone is probably equivalent to the lower part of the Mallapunyah Formation.

A cross-sectional interpretation based on brief examination of the drill cuttings and crude resistivity measurements of some of the chips, strongly supports an interpretation that the conductive zone is related to an up to 30-metre-thick unit of black carbonaceous clay in a laterally limited depression at the base of the cover sequence.

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GEOLOGY OF NORTH COSTELLO PROSPECT
BORROLOOLA PROJECT, NT

8th October 2011

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SUMMARY

The Costello Range in the vicinity of the North Costello QuestEM airborne-detected conductivity anomaly exposes a generally northeast to east facing and dipping sequence of the lower members of the Tawallah Group, from the top of the Yiyintyi Sandstone to the Aquarium Formation. In the southeastern sector, northeasterly dipping Masterton Sandstone and Mallapunyah Formation of the lower McArthur Group overlie the Tawallah Group, probably with slight (but obscured) unconformity. Most of the conductive zone is covered by Cainozoic alluvium. Lithofacies data from Sandfire's 2011 reverse circulation drilling program, regrettably limited by deep weathering, suggests that bedrock beneath the anomalous zone is probably equivalent to the lower part of the Mallapunyah Formation.

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INTRODUCTION

A QuestEM airborne electromagnetic survey flown in 2008 outlined a broad, 6-kilometre-long, semi-horizontal, stratiform-looking conductivity anomaly in the alluvium-covered area east of the Costello Range, about three kilometres east of the Four Archers (Figure 1 and 2). Its stratigraphic location near the probable base of the McArthur Group is consistent with Sandfire Resources' conceptual model for stratiform red-bed copper deposits. Accordingly, during August 2011, Sandfire tested this anomalous zone known as North Costello, with 23 vertical reverse circulation percussion drill holes of up to 200 m depth, totalling 3,100 metres.

This report evaluates the conductive anomaly in terms of its geologic setting based on:

- six days of outcrop mapping at 1:20,000 scale,
- a cursory re-examination of the RC drill cuttings.

Geochemical data from the drilling program was not yet to hand at the time of writing.

All grid references in this report are relative to the GDA datum (MGA94). This report should be read in conjunction with an (A1-size) 1:20,000 scale geologic interpretation map of the North Costello area. It is accompanied by a spreadsheet containing waypoints and structural observations and a gallery of 89 photographs of outcrops and geologic features.

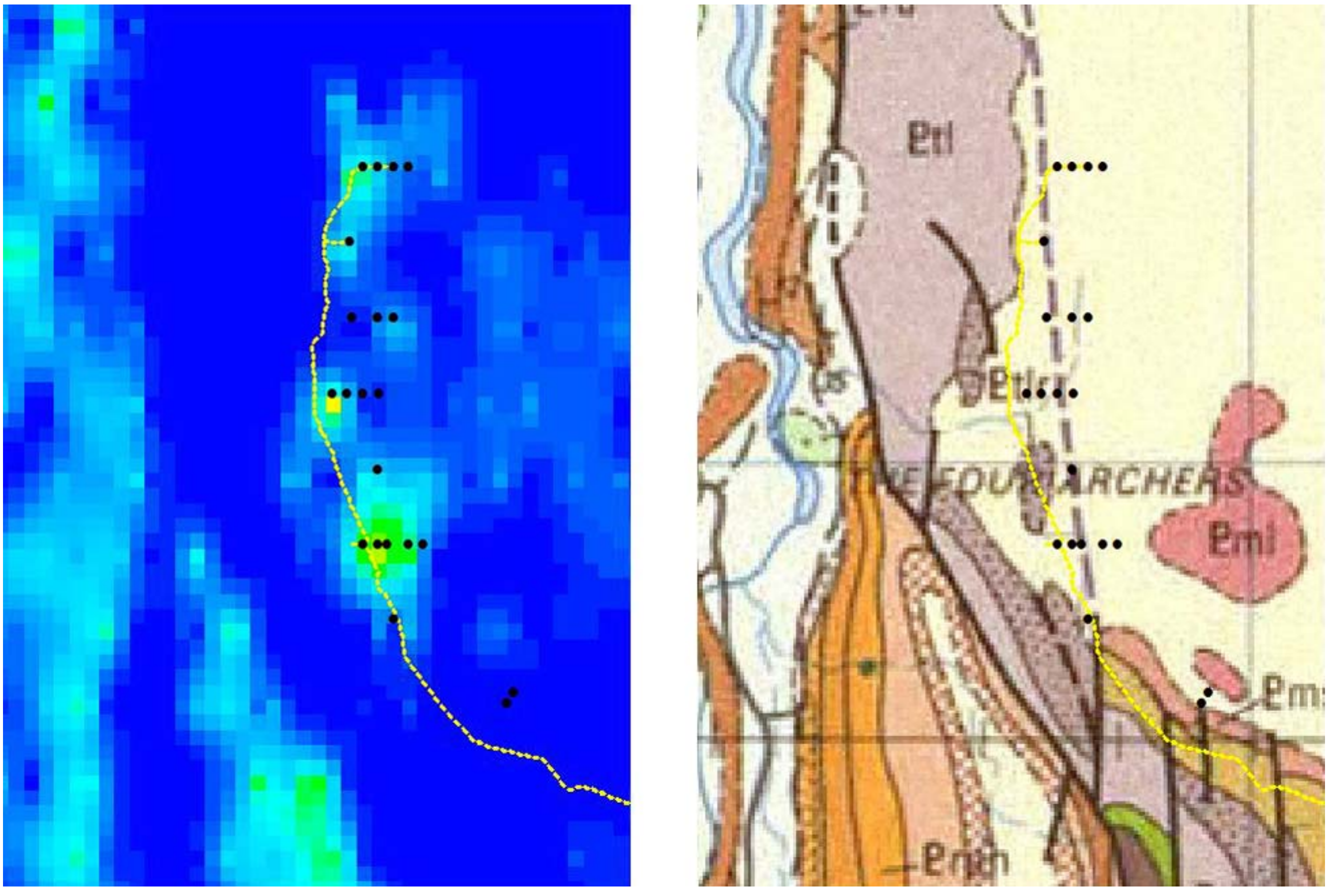


Figure 1. North Costello QuestEM conductivity image (100-150-m depth slice) and surface geology (adapted from Pietsch et al., 1993). The locations of Sandfire's 2011 RC drill holes are shown as black dots. Scale approximately 1:100,000.

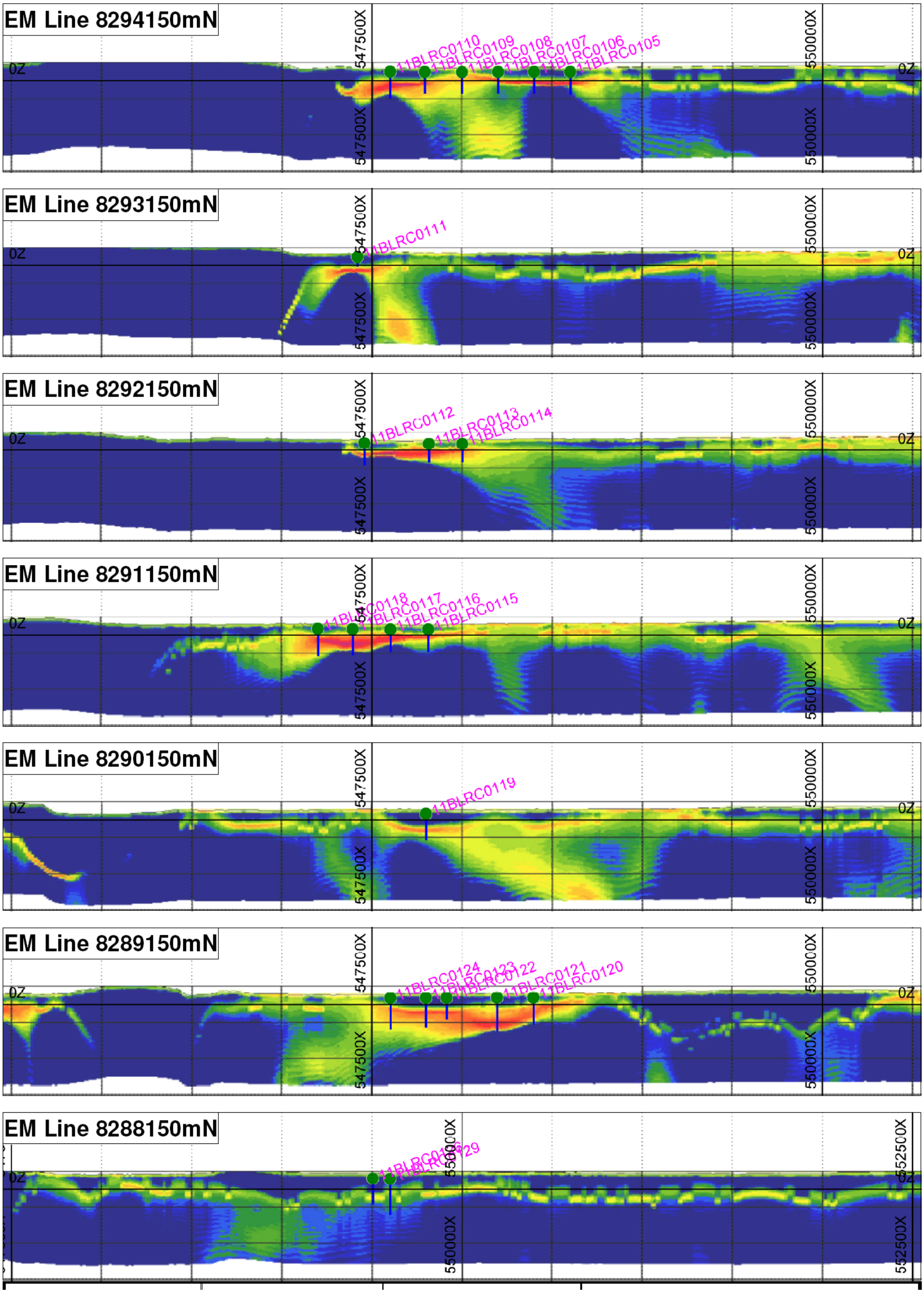


Figure 2. Conductivity pseudo-sections derived from QuestEM airborne electromagnetic survey data showing the locations of North Costello RC drill holes; the vertical grid lines are 500 m apart.

GEOLOGIC SETTING

The QuestEM anomalous zone is devoid of outcrop, in marked contrast to the very high proportion of exposure on the ridge of the northern Costello Range, immediately to its west (refer to 1:20,000 map). A brief examination of RC drill cuttings also revealed disappointingly little about the bedrock lithologies because of deep overburden and weathered zones. Consequently, the geologic interpretation discussed here is largely based on mapping of the peripheral area to the west and south, and some sparse outcrops to the east of the anomalous zone.

Four Archers Fault

The regionally prominent Four Archers Fault along the western edge of the Costello Range separates sandstones of the middle to upper Roper Group on the western side, from the lower Tawallah Group formations that occupy the Range. Although obvious in aerial photographs, the fault is not generally well exposed (e.g. Figure 3) and I'm uncertain of its dip direction. However, near the waterhole at 8285200N, the Roper Group sandstones immediately west of the fault are slightly overturned – dipping steeply to the east but facing west - according to truncated cross bedding. Combined with the apparent asymmetry of the syncline to the west[1], it suggests a concentration of strain adjacent to the fault, probably indicative of some compressional-reverse movement rather than simple normal fault displacement.

Sandstones on both sides of the fault are typically intensively and extensively brecciated, silicified and quartz-stockwork-veined or hematite-cemented, in zones up to about 100-m-wide (e.g. Figure 4). Although common to many of the lesser faults in the Costello Range, this style of deformation and alteration is particularly well-developed along the Four Archers Fault.

Figure 3. View north along the trace of the Four Archers Fault at waypoint NC062, 547880E 8285505N.

Figure 4. Silicified and hematite cemented monomict fault-breccia in Sly Creek Sandstone adjacent to the Four Archers Fault at waypoint NC082, 546220E 8288495N.

Tawallah Group

The northern section of the Costello Range east of the Four Archers Fault exposes a continuous north-east to east facing and dipping sequence of the lower members of the Tawallah Group, from the uppermost Yiyintyi Sandstone to the Aquarium Formation.

South of 8285400N, diffuse-planar-bedded purplish-grey medium-grained sandstone at the top of the Yiyintyi Sandstone formation forms a 30° dip-slope that faces northeast to a 200-m-wide arcuate valley floored by ferricrete and cobbly talus from the adjacent slopes (Figure 5 & 6).

The northeastern side of the valley rises to a scarp and plateau of northeast-dipping, uniformly medium planar-bedded, locally rippled, pink medium grained quartz sandstone. Although hardly diagnostic, this is very characteristic of the Sly Creek Sandstone (Figure 7 & 8). The setting - even including the uppermost purplish Yiyintyi Sandstone on the southwestern footwall – is identical to that at the southwestern margin of Lorella Pocket (~555000E 8255000N) and although I couldn't find any outcrops of the mafic Seigal Volcanic unit here, I have no doubt that it lies under the superficial valley fill.

The Sly Creek Sandstone unit overlying it occupies an outcrop width of about 500 m, with an average dip of about 25° implying a stratigraphic thickness of around 200 metres.

It is conformably succeeded north-eastwards by a similar thickness of variably fine- to mostly coarse-grained, rather poorly-sorted, thick-bedded and commonly cross-bedded quartz sandstones, easily recognizable as the Rosie Creek Sandstone Member. East of the north-trending fault at 548000E, this part of the sequence is roughly equally divisible into a lower section composed of white to pale grey fine-to-coarse bimodally-, and locally quartz-pebbly

[1] Implied by the greater outcrop width of units in the western limb evident in aerial photographs and NTGS 1:250,000 mapping.

trimodally-sorted quartz sandstone (Figure 9), and an upper section of thickly-cross-bedded coarse-grained grey to purplish-grey quartz sandstone with rare pebble-sized sandstone intraclasts (Figure 10 & 11). The lower section is identical to facies of the Rosie Creek Sandstone at the southwestern and northeastern margins of Lorella Pocket (Herrmann, 2011). Further north, near 8289000N, the upper section is a more complex succession of alternating coarse- and fine-grained sandstones, in places thinly-interbedded with cream-grey cherty siltstone characterised by sand filled syneresis cracks (Figure 12).

In the Costello Range southeast of Four Archers, the Rosie Creek Member, has a characteristically tens-of-metres-scale striped outcrop pattern formed by strike-ridges and dip slopes of generally coarser-grained resistant beds, and shelves and shallow valleys of evidently more erodable sandstone; e.g. Figure 13.

Figure 5. Northeast facing dip-slope of purplish-grey medium-grained sandstone at the top of the Yiyintyi Sandstone at waypoint NC053, 548360E 8285375N.

Figure 6. An aerial view from about 548400E 8285400N south-eastwards along the valley of non-exposed Seigal Volcanics; dip-slope of Yiyintyi Sandstone on the right, scarp of Sly Creek Sandstone at left.

Figure 7. Northeast dipping medium-planar-bedded, medium-grained pink Sly Creek Sandstone at waypoint NC051, 548550E 8285685N.

Figure 8. Macro-photo of a weathered perpendicular-to-bedding surface of a specimen of Sly Creek Sandstone, illustrating its typically diffuse layering and well-sorted medium-grained sandy texture; NC161, 547105E 8294055N.

Figure 9. Macro-photo of poorly-sorted coarse-grained quartz-pebbly sandstone in the lower part of the Rosie Creek Sandstone Member at waypoint NC070, 548565E 8286510N.

Figure 10. Coarse-grained cross-bedded quartz sandstone in the upper Rosie Creek Sandstone Member at waypoint NC045, 548830E 8286240N.

Figure 11. Outcrop of thick-diffuse-bedded purplish-grey coarse-grained quartz sandstone in the upper Rosie Creek Sandstone Member at waypoint NC043, 54892E 8286370N.

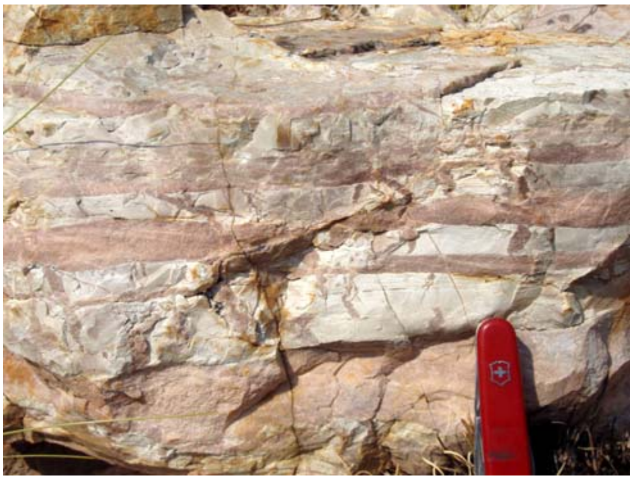


Figure 12. Cross-sectional view of thinly interbedded poorly-sorted fine-to coarse-grained pink sandstone and fine-grained cherty siltstone with sand-filled syneresis cracks; Rosie Creek Sandstone Member, waypoint NC075, 546795E 8289000N.

Figure 13. The panoramic view southwest from the ridge at waypoint NC077 (546740E 8288980N) to the succession of northeast-facing dip slopes in the Rosie Creek Sandstone Member, which appear as parallel stripes.

A kilometre northeast of the ‘Valley of Springs’ gap in the Costello Range (near The Four Archers) the Rosie Creek Sandstone Member is considerably thinned, to less than 100-m-thick. There, north of 8291400N, it is represented mainly by one or two units of spectacular massive coarse clast-supported cobble conglomerate (Figure 14), with subordinate thick bedded quartz-pebbly coarse-grained sandstone (Figure 15), and thin-bedded to flaggy fine-coarse grained sandstone and minor siltstone (Figure 16). In places there are sparsely conglomeratic coarse sandstones (Figure 17), which are apparently transitional to the coarse-grained ± pebbly sandstone most typical of the Rosie Creek Member elsewhere. These support the interpretation that the conglomeratic units are part of that formation.

Near 546300E 8291800N, a unit of thinly bedded fine- to coarse-grained sandstone is conformably sandwiched between two conglomerate units (Figure 18). The sandstone locally has a purplish colour and lenticular hummocky bedding, possibly flaser bedding, which Haines et al. (1993) noted as characteristics of the Aquarium Formation (Figure 19). Accordingly, this conglomerate and thin sandstone assemblage may represent a local transitional facies association at the boundary between the Rosie Creek Member and the overlying Aquarium Formation. This possible transition is more convincingly demonstrated about a kilometre further north, in outcrops near 546355E 8292790N and 546605E 8292680N, where the cobbly conglomerate is directly and conformably overlain by thinly interbedded flaggy red sandstone and (silicified) dolomitic siltstone passing up sequence to silicified stromatolitic dolomites, which are clearly more akin to descriptions of the Aquarium Formation.

Figure 14. Examples of the massive, clast supported, coarse cobble conglomerate that dominates the thinned-down Rosie Creek Sandstone Member on the eastern flank of Costello Range north of 8291000N; upper: waypoint NC149, 546715E 8292440N, lower: waypoint NC136, 546265E 8291685N.

Figure 15. Quartz-pebbly coarse-grained quartz sandstone; Rosie Creek Member, waypoint NC100, 545745E 8290990N.

Figure 16. Lenticularly thin-bedded fine-, medium- and coarse-grained sandstone in a ~3-m-thick unit sandwiched between cobble conglomerate units at waypoint NC140, 546310E 8291930N.

Figure 17. An example of sparsely conglomeratic coarse-grained sandstone representing a transitional facies between the conglomerate and quartz-pebbly sandstone facies (above), and supporting the interpretation that the conglomerates are part of the Rosie Creek Sandstone Member; waypoint NC162, 547130E 8294030N.

Figure 18. Photo (taken in difficult contrasting light and shade) of thin bedded sandstone conformably overlying coarse conglomerate in the creek bank at waypoint NC137, 546320E 8291785N.

Figure 19. Close-up photo of the thin bedded sandstone unit in Figure 18, showing possible flaser bedding; waypoint NC137, 546320E 8291785N.

There are at least three thin units of cherty-silicified dolomites, commonly brecciated and locally laminated-stromatolitic, which are discontinuously exposed between the foot of the Range and the North Costello access track in the 2-km-long strip north of 8291000N. The more siliceous westernmost one crops out boldly (Figure 20). The other two form lower-profile but surprisingly strike-persistent outcrops, which are characteristically brecciated and intensely ferruginized (Figure 21 & 22). These are composed of up to 50% tan, brown and black goethite-limonite with variable compact massive, botryoidal, cavernous, and pseudo-gossanous textures enclosing masses and fragments of cherty silicified rock locally exhibiting thinly laminated probably stromatolitic fabrics (Figure 23). Semi-quantitative analyses of a few specimens by Niton-XRF indicate that the ferruginous pseudo-gossans are geochemically anomalous averaging a few hundred parts per million copper, lead, zinc and arsenic (Table 1).

In the poorly exposed 50 to 150-m-wide zones between the pseudo-gossanous silicified dolomite units, there are sparse low-profile outcrops of two quartz sandstone units, each only a couple of metres thick. They are medium-grained, poorly-sorted, medium diffuse to faintly cross-bedded, locally coarsely rippled, translucent-grey quartz-rich sandstones containing small lenticular solution cavities and ubiquitous 0.5 to 1% fine disseminated to blebby pyrite (Figure 24 and 25). A few specimens have traces of possible chalcopyrite (?) and pale green copper (?) staining.

The dips in this area vary between about 25 and 50° to the east, averaging about 35°. By that estimate, the 600-m-wide package between the foot of the Range and the access track must be around 300 metres thick. Based on their apparent conformity and interbedded continuity with coarse clastics of the Rosie Creek Sandstone Member to the west, I interpret this silicified dolomite-pseudo gossan-pyritic sandstone association to be part of the Aquarium Formation, which Haines et al. (1993) estimate has a thickness of 200-300 m elsewhere. The iron-rich pseudo-gossans and pyritic sandstones may suggest a correlation with the middle unit of the Aquarium Formation, in which Haines et al. (op. cit.) also noted common stromatolites, siderite, and pyrite. Weathering of siderite-rich dolostones could account for the unusual abundance of iron oxides in the pseudo-gossans associated with silicified dolomites at North Costello.

Likewise, a group of three thin, parallel, NNW-N-trending sandstone units in low-profile linear outcrops between 548000E 8287700N and 547300E 8290400N may represent the upper part of the Aquarium Formation, which Haines et al. (op. cit.) described as ‘red-brown mudstone with minor lenticular dolostone decreasing upward and *sandstone interbeds increasing near the top*’. Similarly to the pyritic sandstone units mentioned above, these are translucent grey clean quartz-rich, rather poorly sorted, medium-fine-grained sandstones, diffuse to faintly cross-bedded with mm-cm-scale lenticular solution cavities (Figure 26 and 27). Each bed is only a few metres thick, but they persist in narrow parallel discontinuous outcrops for hundreds of metres. Their composition and bedforms considerably resemble the ‘triplet’ of quartz sandstones that crop out in central Lorella Pocket, near 560500E 8264000N, and which were intersected in some of the south westernmost drill holes at Tawallah 2. Those appear to lie near the base of the Amelia Dolomite (Herrmann, 2011, p.15). However, that stratigraphic correlation is unlikely at North Costello.

The only surface indication of what other more recessive lithofacies of the Aquarium Formation may lie beneath the alluvial cover, and between the siliceous and quartzose units described above, exists in a tiny creek bed outcrop at 549025E 8286335N, only a few metres outboard of the Rosie Creek Sandstone at the eastern foot of the Costello Range. It consists of fissile purplish-grey shale, dipping at 30° to the northeast, in almost perfect concordance with the nearby underlying coarse-grained Rosie Creek Sandstones. A sequence of interbedded red, green and dark grey siltstones and minor sandstone intersected in the lower parts of drill holes 11BLRC 126 and 129, collared about a kilometre northeast of the aforementioned outcrop, is also likely to be a correlate of the more argillaceous upper part of the Aquarium Formation.

Figure 20. Bold outcrop of east-dipping, massive to thinly banded pinkish-white cherty-silicified dolomite and thinly interbedded fine-grained dolomitic sandstone, probably part of the Aquarium Formation; waypoint NC146, 546470E 8291725N.

Figure 21. East-dipping, laminated probably stromatolitic silicified dolomite outcrop at waypoint NC124, 546840E 8291290N.

Figure 22. Highly ferruginous outcrop, 150 metres along strike to the north, in the same unit as in Figure 21; waypoint NC126, 546785E 8291420N. Niton XRF analyses indicate samples from this outcrop are anomalous in base metals and arsenic, containing up to 800 ppm Cu.

Figure 23. Cavernous botryoidal and pseudo-gossanous textured goethite and limonite in ferruginous silicified dolomite; waypoints NC125 and NC128, 546775E 8291540N and 546640E 8291370N, respectively.

Figure 24. Macro photo of a reddish weathered surface of the pyritic sandstone unit at waypoint NC147, 546675E 8291940N, showing its faint cross bedding and cm-scale lenticular solution cavities.

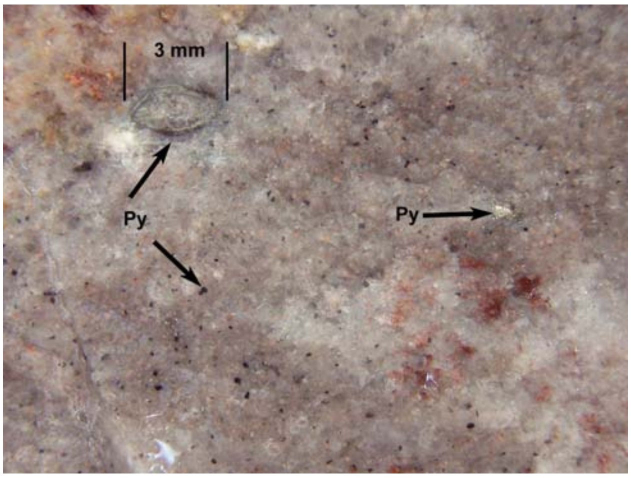


Figure 25. A fresher fractured surface of the pyritic sandstone unit at waypoint NC147, 546675E 8291940N illustrates the distribution and morphology of pyrite, mainly in partly oxidized fine-grained specks (evenly disseminated black dots), occasional mm-scale bright blebs (centre right) and rare elliptical concentric framboids (~3 mm, upper left).

Figure 26. Outcrop- and macro-scale photos of thin planar bedded medium-fine-grained quartz sandstone with mm-scale lenticular solution cavities; waypoint NC103, 547170E 8290200N.

Figure 27. Cross bedded medium-fine-grained quartz sandstone; waypoint NC104, 547270E 8290145N.

McArthur Group

The sinuous northwest-trending low scarp that extends for 3½ kilometres parallel to the access track at the southern end of the prospect exposes a gently northeast dipping, broadly upward-fining, succession of coarse, medium and fine grained quartz sandstones, locally overlain by erosional remnants of flat lying Mesozoic semi-lithified pebbly conglomerate (Figure 28).

The lowermost unit is mostly poorly sorted, medium-coarse-grained, pink quartz sandstone with local minor pebbly bands, rather well stratified at centimetre-scale but in medium to thick planar beds at outcrop scale (Figure 29, 30 and 31). The overlying middle unit is more uniformly medium-grained pink sandstone commonly cross bedded or rippled in thin to medium beds (Figure 32). The uppermost unit is variably pink to white, medium- to coarse-grained (locally fine-grained) poorly sorted quartz sandstone. It is less well exposed and generally separated from the previous units by a 60-m-wide strip of no outcrop. The average dip of about 15° to the northeast and outcrop width of up to 400 metres imply a thickness of about 100 metres for this group of sandstones. They peter out to the north, just south of drill hole 11BLRC125, at about the position of the set of north-trending faults that splay off the Four Archers Fault and offset the lower Tawallah Group units along about 548000E.

The lithofacies are not particularly diagnostic but taken together with the thickness, general stratigraphic setting, lateral impersistence, and possible slight angular unconformity with the lower Tawallah Group units on the adjacent Range[2] they are consistent with the NTGS' interpretation that this series of sandstones is a correlate of the Masterton Sandstone, at the base of the McArthur Group.

[2] Where the dips average about 25° to the northeast. Haines et al. (1993) noted marked thickness variations in the Masterton Sandstone, attributable to an uneven erosional surface and syn-sedimentary tectonism that was substantially eliminated by the time the uppermost Masterton was deposited.

There is a 300-metre-wide gap in outcrop between the uppermost exposed Masterton Sandstone unit and two low ridges of silicified dolomite located just north of drill hole 11BLRC129. Although completely silicified at surface and largely brecciated (Figure 33) these outcrops retain some convincingly well-preserved oolitic and layered-domal stromatolitic textures (Figure 34 and 35). The regularly layered parts dip gently at 15° to the northeast in apparent perfect conformity with the probable Masterton Sandstones to the nearby southwest. Accordingly, it is likely that these are in the lower part of the Mallapunyah Formation, possibly interbedded with and underlain by more erodable mudstones in the adjacent covered strips. The rather weathered heterogenous reddish chips of siltstone and variably fine-medium-coarse-grained sandstone intersected in the upper 45 metres of drill hole 11BLRC129 are probably representative of this lower section of the Mallapunyah Formation.

The proportion of Proterozoic outcrop diminishes northwards where there are further low profile remnants of Mesozoic sandstone (Figure 36). I found three northwest trending arcs of sandstone represented mainly by bouldery rubble, in the area about a kilometre east of 11BLRC120. These are variably thin- to medium-diffuse-bedded, locally rippled or faintly cross-bedded, poorly sorted fine to medium (locally coarse) grained pale grey quartz sandstones. They are lithologically rather like the three linear north-trending sandstones near the access track about two kilometres to the west, and likewise are probably each only a few metres thick (Figure 37 and 38).

The sandstone units are interbedded with less well exposed cherty-silicified dolomitic and stromatolitic siltstones, which locally exhibit decimetre-scale interbeds of sandstone (Figure 39 and 40).

The few dips observable here are all gentle at 10 to 15° to NNE and NE, and judging by the small-scale interbeds and parallel strike trends, this assemblage can be considered a continuous conformable sequence. The dip and outcrop width of about 1,200 metres imply a local thickness of around 300 metres.

The broad similarities in lithofacies and stratigraphic thickness (albeit probably incompletely observed) invite correlation between this eastern sector (east of 11BLRC120) and the ferruginous-silicified dolomite and sandstone sequence west of the access track, which I interpreted to be Aquarium Formation. However, the parallel trend and gentle dips are more consistent with this eastern sequence laying stratigraphically above the Masterton Sandstone-Mallapunyah Formation only a few hundred metres to the southwest; i.e. only about 100 metres stratigraphically lower. Thus, the eastern sequence is likely part of the Mallapunyah Formation.

The total surface width of about 2,000 metres, between the upper Masterton Sandstone unit and the north-easternmost outcrops, implies a stratigraphic thickness of about 500 metres. That is not definitive but nevertheless within the possible thickness range of Mallapunyah Formation, which Haines et al. (1993) estimated has a maximum thickness greater than 320 metres in the western part of the Mount Young sheet, and which appears to be about 500 metres thick in the central-west of Lorella Pocket (Herrmann, 2011).

Figure 28. Flat lying Mesozoic clast supported pebbly-cobbly conglomerate; waypoint NC018, 549485E 8286875N.

Figure 29. Outcrop of east-dipping planar bedded coarse-grained pink quartz sandstone at the base of the Masterton Sandstone; waypoint NC001, 551050E 8285800N.

Figure 30. Macro photo of coarse-grained pink quartz sandstone in the outcrops depicted above; the coarsest grains are about 1.5 mm diameter. Waypoint NC001, 551050E 8285800N.

Figure 31. Minor discontinuous bands of matrix supported pebbly-cobbly conglomerate exist in the coarse sandstone facies near the base of the Masterton Sandstone; waypoint NC034, 549300E 8286540N.

Figure 32. Gently north-northeast dipping thin-bedded, ripple marked, medium-grained pink quartz sandstone; waypoint NC003, 550940E 8285970N.

Figure 33. Silicified dolomite breccia in outcrops on the ridge north of 11BLRC129. The angular clasts of grey chert have mm-scale spherical oolitic textures as depicted in Figure 34. Waypoint NC014, 549570E 8287330N.

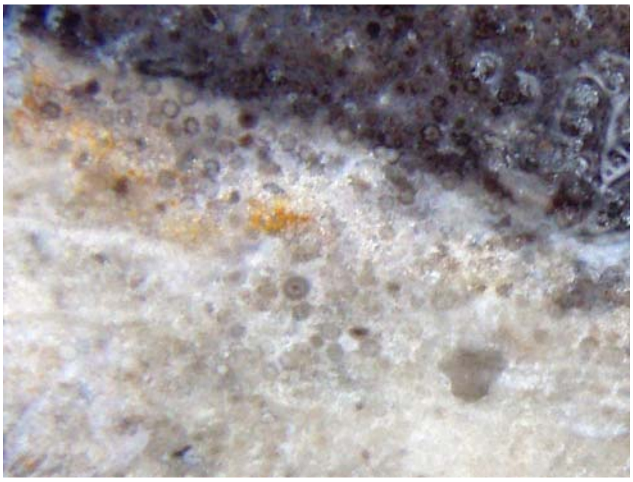


Figure 34. Millimetre-scale spherical oolitic textures in angular clasts. of grey chert in silicified dolomite breccia; waypoint NC014, 549570E 8287330N.

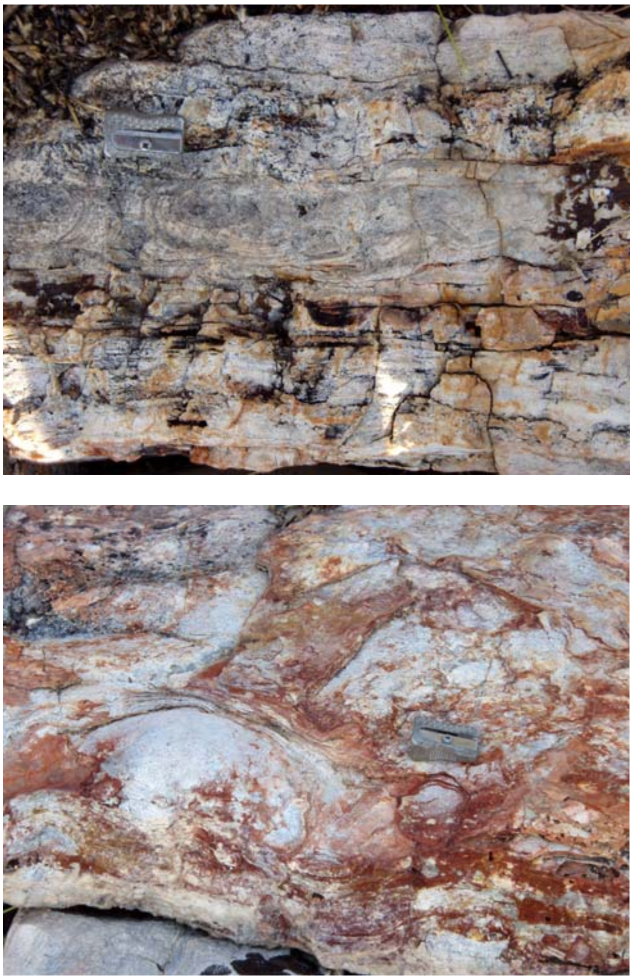


Figure 35. Centimetre- to decimetre-scale layered and domal bedforms in cherty silicified dolomite at waypoint NC013, 549580E 8287280N.

Figure 36. The thin Mesozoic cover of flat lying kaolinitic fine-grained sandstone, and a fragment of a molluscan fossil (Pecten sp?), in outcrop at waypoint NC109, 550010E 8289385N.

Figure 37. Low-profile rubbly outcrop of faintly cross-bedded poorly sorted fine-medium grained quartz sandstone typical of the area east of drill hole 11BLRC120. Waypoint NC117, 549035E 8288995N.

Figure 38. Faintly cross-bedded poorly sorted fine-medium grained quartz sandstone typical of the area east of drill hole 11BLRC120. Waypoint NC111, 549795E 8289370N.

Figure 39. Laminated and domal stromatolitic forms in silicified dolomitic siltstone; waypoint NC123, 549205E 8288275N.

Figure 40. Thinly interbedded fine-grained sandstone and silicified stromatolitic dolomitic siltstone, waypoint NC112, 549655E 8289435N.

RC DRILLING INTERPRETATION

The results of the North Costello reverse circulation drilling program are generally disappointing from a litho-stratigraphic point of view, because of the great depth of overburden and weathering in most of the 23 holes.

Drill hole 11BLRC121, one of the deeper holes in the centre of one of the most conductive zones (Figure 2), is a fair example.
My summary chip log records its lithofacies as follows:

0 – 118 m	mottled pink, tan, pale grey and cream coloured plastic clay and stony clay
118 – 135 m	olive grey plastic clay
135 – 167 m	dark grey to black carbonaceous silty clay, with slight whitish efflorescence spots (suggesting oxidation of invisible pyrite?)
167 – 168 m	sub rounded tan coloured sandstone pebbles
168 – 173 m	pale whitish grey stony clay
173 – 186 m	pale grey laminated chert = silicified dolomitic siltstone, possibly stromatolitic.

Figure 42 depicts the marked colour variations in the RC drill cuttings below 60 m depth. Based on the thin layer of sub rounded and obviously water worn pebbles below the black clay, which were also intersected in the adjacent holes, I am fairly sure that all the 'units' above 168 m in 11BLRC121 are transported cover, and that the hole penetrated less than 20 metres into bedrock.

The association of black clay with a basal pebbly layer underlain by white-pale grey kaolinitic clay was also intersected in the adjacent holes 120 and 122, but surprisingly at higher levels, as depicted in sketch section Figure 41. The variably weathered grey and pink siltstone and laminated cherty (silicified stromatolitic dolomite) lithofacies that comprise the bedrock sequence beneath the black mud group on section 8289150N, are likely correlates of the units that crop out near 11BLRC 129, and may have been intersected in the upper part of that hole; i.e. the lower members of the Mallapunyah Formation.

The distribution the black mud facies suggests it was deposited in a local basin, possibly over karst in the underlying dolomite, with continued subsidence after the black mud accumulated. It is unlikely that these non-lithified sediments are tectonically deformed. The banana-shaped 'basinal' form in cross-section is notably similar to the QuestEM-derived conductivity profile on that section; c.f. Figure 2.

That similarity prompted me to carry out some crude resistivity measurements[3] on the RC drill cuttings from 11BLRC121, which showed that the black mud unit is roughly an order of magnitude less resistive than the overlying clays, and up to four orders of magnitude less resistive than the silicified dolomite at the bottom of the hole. Annotations on Figure 42 show the apparent electrical resistances in relation to the lithofacies and depths down the hole.

Despite the crudity of these petrophysical data, the remarkable similarities between the extents and depths of the conductive zone and the black mud unit in the drill holes substantially support an interpretation that the black mud is the source of the geophysical anomaly.

[3] Using a digital multimeter from the workshop at Sandfire's Lorella Camp, with the probes placed about one centimetre apart on individual 'chips', in their trays and in their natural damp condition.

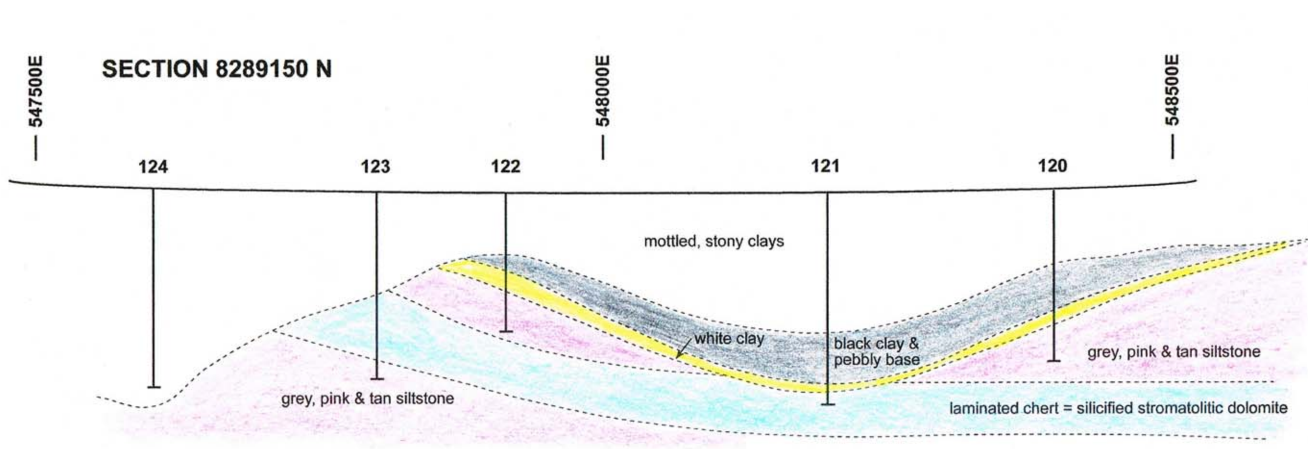


Figure 41. Geologic interpretation of cross section 8289150N based on a cursory examination of RC drill cuttings; the scale is ~1:6,600 without vertical exaggeration.

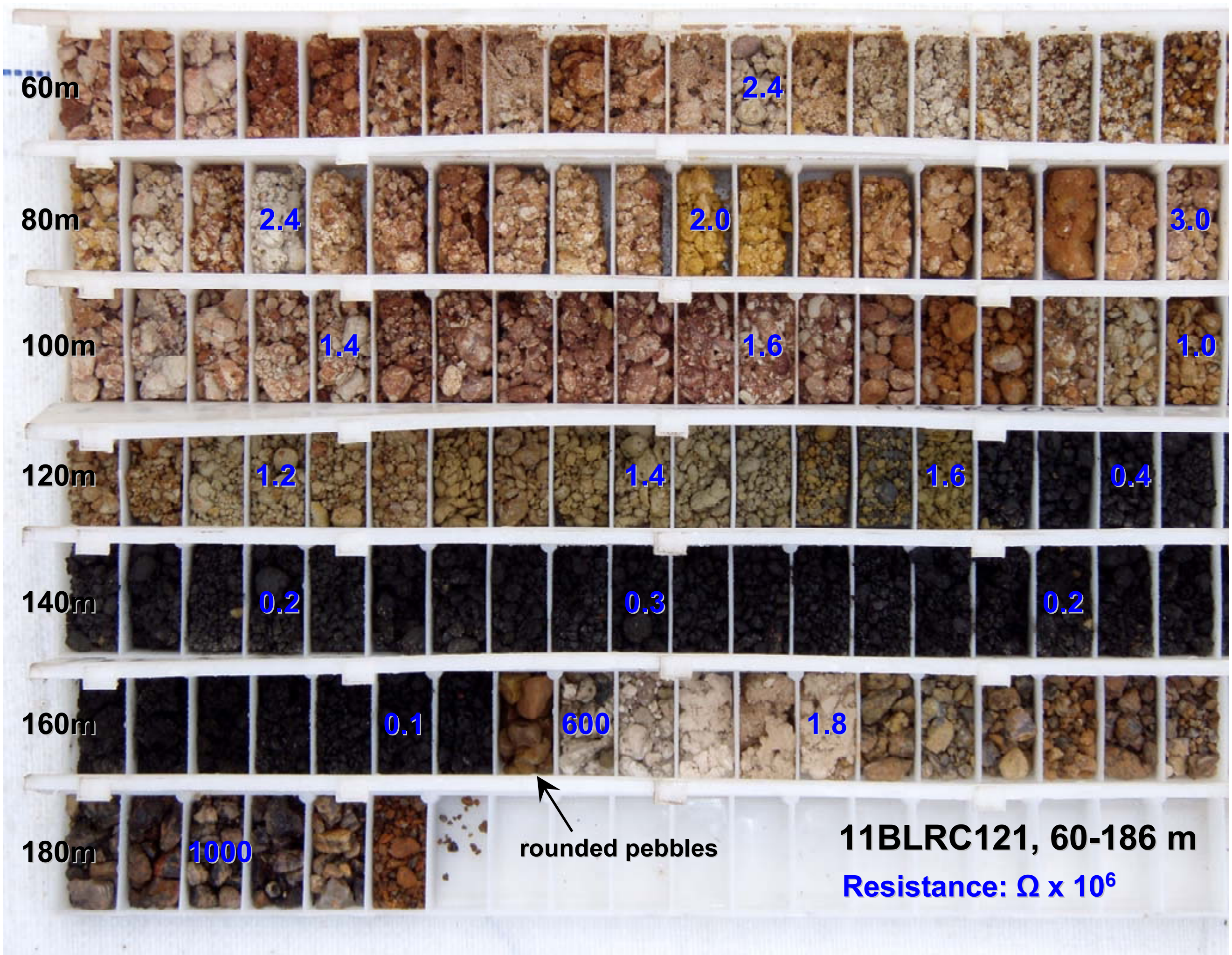


Figure 42. Annotated photograph of the chip trays containing washed cuttings from 60 to 186 m depth in drill hole 11BLRC121. The annotations in blue are apparent electrical resistances of chips (in ohms x 10^6) measured with a digital multimeter.

Table 1. Semi-quantitative Niton-XRF analyses of rock specimens.

SAMPLE	**G1**	**G1**	**G1**	**G1**	**G1**	**NC126**	**NC126**	**NC127**	**NC147**	**NC147**
Description	Fe-Mn Pseudogossan	Fe-Mn Pseudogossan	Fe-Mn Pseudogossan	Fe-Mn Pseudogossan	Fe-Mn Pseudogossan	Fe-Mn Pseudogossan	Fe-Mn Pseudogossan	Pyritic Sandstone	Pyritic Sandstone	Pyritic Sandstone
GDA East	555148	555148	555148	555148	555148	546785	546785	546739	546677	546677
GDA North	8269106	8269106	8269106	8269106	8269106	8291421	8291421	8291377	8291938	8291938
Reading No	290	291	292	293	294	295	296	299	297	298
Time	8/10/2011 7:32	8/10/2011 7:34	8/10/2011 7:36	8/10/2011 7:37	8/10/2011 7:38	8/10/2011 7:40	8/10/2011 7:41	8/10/2011 7:49	8/10/2011 7:45	8/10/2011 7:46
Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Duration	30	30	30	30	30	30	30	30	30	30
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Pb	127	< LOD	108	< LOD	< LOD	< LOD	266	< LOD	< LOD	< LOD
As	136	227	< LOD	88	316	643	123	< LOD	< LOD	< LOD
Zn	57	< LOD	< LOD	< LOD	94	296	255	< LOD	< LOD	< LOD
Cu	< LOD	< LOD	< LOD	< LOD	< LOD	600	800	< LOD	< LOD	< LOD
Fe	1,856,153	2,231,037	1,296,128	80,610	1,126,712	2,439,834	1,893,044	1,299	1,561	1,823
Mn	116,395	11,249	11,346	931,579	533,060	7,783	3,719	38	141	299
Pb 2σ	66	118	47	24	68	122	71	4	4	4
As 2σ	39	47	40	13	32	57	43	3	3	3
Zn 2σ	29	54	32	35	28	53	45	6	6	6
Cu 2σ	82	107	60	71	76	94	89	13	12	11
Fe 2σ	4,905	6,075	3,471	1,347	3,668	6,432	5,041	47	48	50
Mn 2σ	1,603	810	533	3,700	3,086	782	573	22	25	30

ACKNOWLEDGEMENT

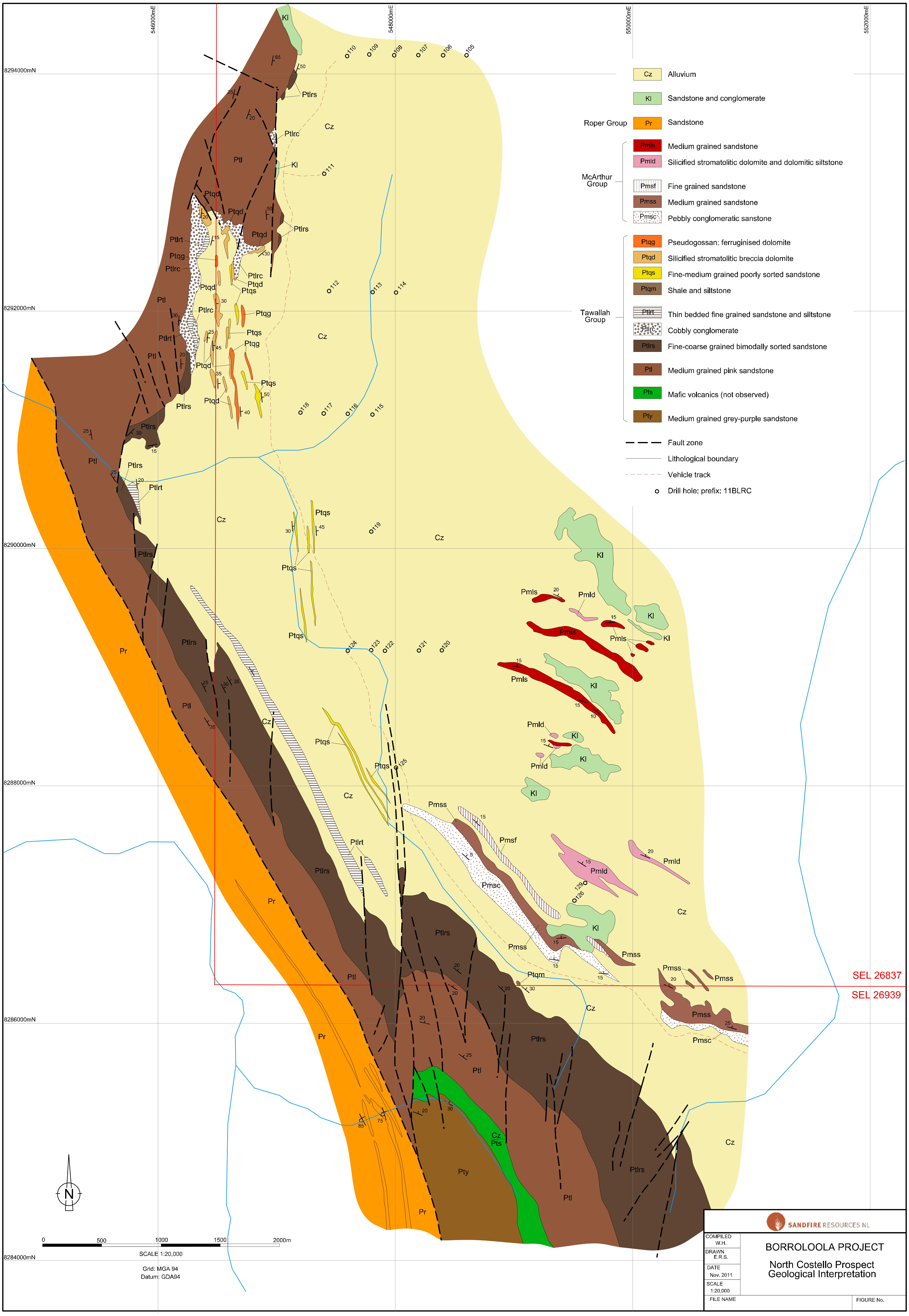
Andy Hansen helpfully provided the conductivity pseudo section image in Figure 2, and Niton XRF analyses in Table 1.

REFERENCES

Haines, P. W., Pietsch, B. A., Rawlings, D. J., and Madigan, T. L. A., 1993, 1:25,000 Geological Map Series, Explanatory Notes, Mt Young SD53-15, p. 81.

Herrmann, W., 2011, Geology of Lorella Pocket, Borroloola Project, NT: unpublished company report, Sandfire Resources NL, 23 p.,

Pietsch, B. A., Haines, P. W., Rawlings, D. J., Madigan, T. L. A., and Kruse, P. D., 1993, Mount Young SD 53-15 1:250,000 Geological Map, 2nd edition, NT Geological Survey.



Cz Alluvium
Kl Sandstone and conglomerate
Roper Group
Pr Sandstone
McArthur Group
Pmls Medium grained sandstone
Pmld Silicified stromatolitic dolomite and dolomitic siltstone
Pmsf Fine grained sandstone
Pmss Medium grained sandstone
Pmsc Pebbly conglomeratic sanstone
Tawallah Group
Ptqg Pseudogossan: ferruginised dolomite
Ptqd Silicified stromatolitic breccia dolomite
Ptqs Fine-medium grained poorly sorted sandstone
Ptqm Shale and siltstone
Ptlrt Thin bedded fine grained sandstone and siltstone
Ptlrc Cobbly conglomerate
Ptlrs Fine-coarse grained bimodally sorted sandstone
Ptl Medium grained pink sandstone
Pts Mafic volcanics (not observed)
Pty Medium grained grey-purple sandstone
Fault zone
Lithological boundary
Vehicle track
Drill hole; prefix: 11BLRC
SEL 26837
SEL 26939
546000mE
548000mE
550000mE
552000mE
8294000mN
8292000mN
8290000mN
8288000mN
8286000mN
8284000mN
0 500 1000 1500 2000m
SCALE 1:20,000
Grid: MGA 94
Datum: GDA94
N
SANDFIRE RESOURCES NL
BORROLOOLA PROJECT
North Costello Prospect
Geological Interpretation
COMPILED W.H.
DRAWN E.R.S.
DATE Nov. 2011
SCALE 1:20,000
FILE NAME
FIGURE No.