Appendix D

Preliminary Seismic Interpretation

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Report to Zeehan Zinc Pty Ltd on short seismic interpretation, ZEEHAN 1:50 000 map sheet area.

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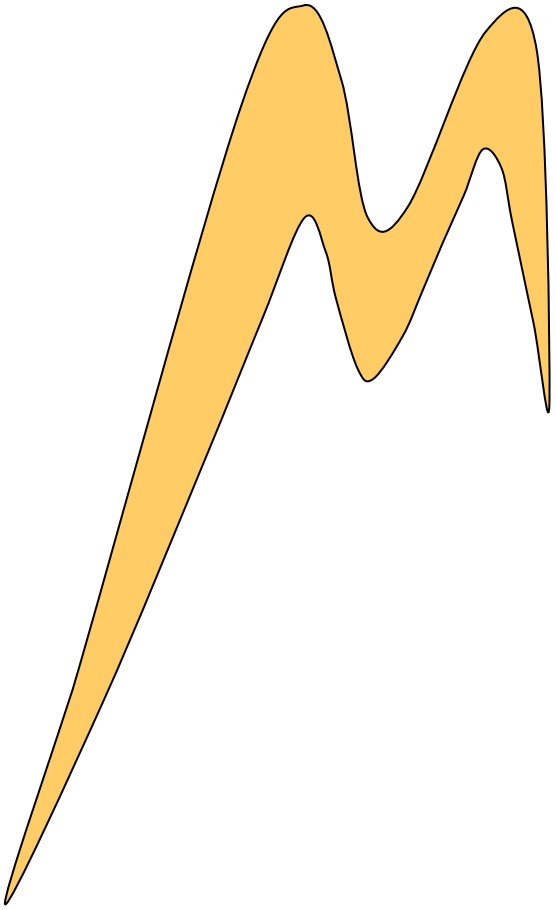

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FIGURES LIST

DISCLAIMER

This study is a reconnaissance study based on what was a brief review of seismic data which were collected from a very complexly faulted and folded series of rocks, and which was not supported by a drilling programme to ground-truth the rocks at depth. As such there will be errors in my interpretation. Therefore I accept no financial or material liability for the failure of any exploration, mining or investment activity based on my interpretations, and nor do I accept any liability for financial or material loss incurred by any party should my interpretations be used for promotion of the study region to investors or financial institutions. It should be noted also that I have raised for consideration geological possibilities which may not sit well with current thought about Tasmanian geology.

EXECUTIVE SUMMARY

The seismic programme carried out by Zeehan Zinc Pty Ltd has the potential for revealing the previously not well understood regional deformation style and critical rock relationships in that it appears to show important 3-dimensional information concerning the shallow (200-300m deep) to deep (5-6km deep) structural geological evolution of the exploration licences held in the Zeehan district by Zeehan Zinc Pty Ltd. The work can be interpreted to confirm thin-skinned thrust tectonics across the area to depths of about 3000m, with production of numerous concomitant and seismically identifiable structural geological fairways for mineralising fluids and mineralisation in the appropriate chemical environments.

The seismic images can be interpreted as showing that thin-skinned thrust tectonics has produced a 1.2 to 1.5 second deep (approx. depth 2 400-3 000m) thrust-stack overlying a very poorly reflective basement, which incorporates at between 1.6 and 2.1 seconds depth (approx. 3 200 to 4 200m depth) a subhorizontal textural zone indicative possibly of a regional granitic sill extending from west to east across the study area.

The seismic data, when considered with gravity and magnetic geophysical data, point to the presence of possibly nickeliferous Cambrian rocks both below the Precambrian and Ordovician series immediately west and south of Zeehan and within Zeehan Zinc's exploration licence.

The seismic data indicate also the probable subterranean extent of the Heemskirk Granite, which accords reasonably with geophysical information, and also demonstrates the previously unknown probability

of post-granite thrusting or reverse faulting, possibly related to Palaeocene to Middle Tertiary tectonics related to major strike-slip faulting. This interpreted faulting may involve a seismic reflector indicative of shallowly dipping beds and may be of significance to oil exploration both offshore and onshore

TASK

I was requested by Zeehan Zinc Pty Ltd initially to spend as many as 30 working days carrying out an interpretation of data from four seismic lines acquired by Fugro Ltd on behalf of Zeehan Zinc, together with a regional structural geological analysis of the ZEEHAN 1: 50 000 sheet area (Fig. 1) and an interpretation of drill-hole and geophysical data. The work was terminated after 16 working days because of a change in Zeehan Zinc's budget priorities.

I was provided with access to seismic sections in digital format and on paper, and worked on interpreting the data in both formats.

I was also provided with the 1: 50 000 and 1: 25 000 MRT maps of the ZEEHAN quadrangle. These maps differ in detail, particularly in the colours and ages assigned to some of the Cambrian sedimentary series in the eastern part of the map-sheet. My enquiries to Dr Calver of the MRT confirmed that additional ideas had been incorporated in the 1:25 000 sheets since the publication of the 1:50 000 ZEEHAN map and that the 1:25 000 maps were the more up-to-date.

I prepared a preliminary interpretative structural geological map using the 1:50 000 geological map and scanned and registered it in MAPINFO (see Figure 2 and digital imagery attached to this report). The budgetary constraints imposed part way through the project have prevented me from digitising and refining this image for more detailed interpretation.

I was assisted in the work by Mr Diego Gonzales of Great Southland Minerals Pty Ltd, who introduced me to the software for interpretation and assisted me in discussing problems.

I have assumed that 0.1 of a second return-time is equivalent to 200m depth, based on discussions with Mr Gonzales. This is an approximation only and requires due caution in its acceptance.

BROAD STRUCTURAL GEOLOGICAL OVERVIEW

Figures 1 and 2 (see also MAPINFO file Zeehan_structural_interp.tab on the CD accompanying this report) indicates that the area consists of a series of thrust-sheets containing rocks of Precambrian to Late Devonian age faulted against Permian and Jurassic rocks to the southwest and apparently intruded by the Late Devonian Heemskirk Granite pluton in the west. The overall geometry suggests SE transport, which has been confirmed at one locality only, close to the 10th Legion Fault at the Swansea Tram road above the tailings dump of the Comstock mine, by staff of the

MRT in 1990 (Findlay and Brown 1992; see also Findlay 1993 for an additional and more widespread detailed discussion of the regional thrusting in the Zeehan district). The thrust sheets terminates in the south, in the northern part of the STRAHAN 1:50 000 quadrangle, where the thrusted Cambro-Devonian series displays a poorly mapped and hence enigmatic relationship to Permian sedimentary units; it appears as if the Permian rocks here overlie the Lower Palaeozoic series with an unconformity and yet are cut by faults that can be interpreted as lateral ramp thrusts related to the regional supposedly pre-Late Devonian thrusting (Fig.2, inset).

The Precambrian to Devonian rocks involved in the thrusting are also folded strongly about NNW-SSE trending axes which are cut by the thrusts. As mapped, these folds appear to precede the Late Devonian Heemskirk Granite.

The thrust sheets are juxtaposed in the east against a Cambrian sedimentary and igneous series by a poorly known, possibly east-dipping or SE-dipping reverse fault or thrust array. These Cambrian rocks appear to have been folded before thrusting.

The post-Permian faulting seen in the west of the ZEEHAN and STRAHAN 1:50 000 sheet areas may be represented near Zeehan by a reverse fault in the Montana Mine north of Zeehan (Fig. 3). This fault, identified by Blissett and Gulline (1962), dips southeast at 45^{o} and juxtaposes the Precambrian Oonah Formation over Permian tillite. According to my previous mapping in the MACQUARIE HARBOUR 1:50 000 quadrangle (McClennaghan and Findlay 1993) and information in the 1:50 000 STRAHAN map-sheet, I consider that the post-Permian faulting may have developed during sinistral strike-slip motion more-or-less along, and close to parallel to, the west Tasmanian coast during the separation of Australia from Antarctica (see also Stacey and Berry 2004). Such faulting could create structures useful as hydrocarbon traps both offshore and onshore.

Further evidence of post-Permian deformation is presented through the steep SE-trending cleavage seen within the Permian tillite north of Zeehan (Fig. 3) and in the area of the Pieman Dam (Findlay, pers. obs. 1989-1991). The trend of this cleavage follows that seen in the folded Ordovician-Devonian beds.

SEISMIC INTERPRETATION

In this section I summarise the key features of each section. The reader is referred to the accompanying annotated seismic sections.

SEISMIC LINE ZA-along the Murchison and Zeehan Highways (sealed roads)

- This section follows a complicated alignement; in the north the line crosses the strike of faulted Cambrian units, in the central part it runs oblique to the faults separating the Cambrian units and the Gordon Limestone and also is oblique to the general structural and bedding trends between the Gordon Limestone and Eldon Group further west, and in the south it crosses the boundary between Eldon Group rocks and the Cambrian series at about 45^{o}.

- The general appearance of this section is that it consists of a north-verging thrust-stack, containing shallowly dipping thrusts, thickening southwards from perhaps 0.8 seconds in the north to 1.8 seconds in the south. However, the dips of the probable faults are apparent dips only, and the direction of true dip of the faults ranges between ESE to WSW, implying northwards or westwards-directed transport. The true dip of the faults cannot be determined.

- The interpretation of the structure as a WNW- to ENE-verging thrust-stack is at odds with the interpretation from field data (Findlay and Brown 1991) that the 10th Legion Fault is part of a thrust system transported from the north to NW. This may indicate two generations of post-Early Devonian thrusting, rather than just one. This could accord with data reviewed in Findlay (1993).

- As with other sections there is a distinct, finely textured zone between about 1.9 seconds and 2.6 seconds depth; this may be a thick sill of possibly Devonian granite.

- The zone referred to above is interrupted in the south by a bollard-shaped zone containing numerous distinct subhorizontal reflectors; no salt domes have been recorded in Tasmania.

SEISMIC LINE ZB-old mining track between Oceana and Maiposa mines

This section runs along a newly cleared, unsealed road with a swampy area more or less mid-section. This swampy area gives no reasonable seismic response.

The central section crosses almost orthogonally the broad post-Early Devonian syncline trending NW across the study area. The western and eastern parts of the section follow the predominant strike of the rocks in these areas.

- There are no good reflectors that can be correlated with the different rock units in the regional post-Early Devonian syncline.

- The western part of the section can be interpreted as underlain by thrusts and thrust duplexes with a westward vergence, similar to seismic section ZA. The thrusts appear to be dipping reasonably shallowly, although the true dips cannot be determined.

- It is likely that Late Cambrian beds in the west overthrust the Ordovician Gordon Limestone and thus mineralised zones in the limestone may underlie the Cambrian units.

- Between 1.8 to 2 seconds (3 600-4 000m) there is a texturally distinct zone, as in section ZA, which, although not bound by sharp reflectors, may be a distinct rock unit. This zone is visible in the other seismic sections and may be a subhorizontal granitic body

SEISMIC LINE ZC –Pieman Dam road NW out of Zeehan

This line extends from just south of Zeehan, through Zeehan to within the Permian tillite on the Pieman Dam road NW of Zeehan. The section crosses the contact between the Oonah Formation and the Palaeozoic rocks north of Zeehan at a high angle; south of Zeehan it runs more-or-less parallel to the strike of bedding in the Eldon Group and Gordon Limestone, although again here it tends to cross the main mapped faults at a high angle. Thus the apparent dips of the faults in the seismic section may be close to the true dips.

- Overall, the section demonstrates the geometry of a thrust stack thinning southwards from 1.6 seconds (about 3 200m) depth to 0.5 seconds. The geometry is consistent with generally southward directed thrusting, in agreement with observations at the 10th Legion Fault near the Comstock Mine (Findlay and Brown 1991).

- In the region between Zeehan and the south end of the section, the Eldon Group may be no thicker than 0.2 seconds (about 400m). As the Eldon Group is underlain by the Gordon limestone which contains SEDEX deposits (C. Burrett pers. com. 2005) of Pb, Zn and Ag the seismic section demonstrates the mineable potential sub-surface extension of the already known Pb/Zn/Ag mineralisation south of Zeehan.

- In the Zeehan area, the geological map indicates that the Oonah Formation overthrusts the Cambrian series northwest of Zeehan, the Gordon Limestone to the north and also the Eldon Group to the northeast and south. As mapped, the thrust dips very shallowly; this is consistent with the seismic data which limits the thickness of the Oonah Formation here to no more than 0.2 seconds (approx. 400m). As the Cambrian series is a host for igneous rocks that elsewhere contain nickel, as the Central Balstrup mine in Cambrian rocks west of Zeehan was a minor nickel producer and, as noted above, the Gordon Limestone hosts SEDEX mineralisation, then seismic section ZC confirms additional, easily accessible prospectivity in the Zeehan area. It follows that a more extensive exploratory drilling programme, coupled with a micro-gravity survey in this area, could be beneficial.

- In the Montana Mine, north of Zeehan, Permian rocks are reverse faulted against the Oonah Formation (Blissett and Gulline 1962). The fault dips SE at 45^{o}. The seismic section shows a possible thrust and reverse fault in this area, dipping southward. If these features are real, and constitute backthrusts within the thrust-stack, as seems the simplest explanation, then the thrust-stack post-dates deposition of the Permian sedimentary series. This is not the accepted wisdom for interpretations of Tasmanian geology.

- The northern part of the section shows prominent apparently shallowly SE dipping reflectors below 1.7 seconds. These are overlain by the thrust-stack, and lie within the area where gravity data suggest the southeastern extension of the Heemskirk Granite. These reflectors have a very different seismic signature from that of the zone interpreted as hosting the Heemskirk Granite in

Seismic Section ZF and which extends from mapped surface outcrops of granite along the Trial Harbour road. There are other possibilities; either the prominent reflectors are bedded Permo-Triassic rocks (Parmeener Supergroup), they may represent thick, well-bedded and only weakly deformed Precambrian or Early Palaeozoic basement or they signify deep Jurassic dolerite. If the reflectors are from the Parmeener Supergroup then this section confirms post-Permian/Triassic thrusting of considerable extent. Such an idea conflicts with accepted interpretations of Tasmanian geology.

- The section shows a horizontal zone of finer texture between 2 and 2.6 seconds. This is similar to those seen in previous sections but is a little deeper. This zone terminates against the shallowly dipping deep reflectors in the north of the section.

SEISMIC SECTION ZD-Zeehan to Heemskirk Highway (sealed road)

This section crosses a major SE trending syncline in the Eldon Group (Fig. 4), with the Bell Shale in its core and the Gordon Limestone on its flanks. The central part of the section crosses strike at high angle, in contrast to the limbs of the fold where the section is parallel to strike (eastern part) and is oriented at about 60^{o} to strike in the west.

- The section crosses outcrops where the Bell Shale dips steeply to vertically, and steep dips are also reported from the limbs of the syncline. These steeply dipping, bedded rocks do not provide a seismic signature.

- The only reflectors evident in the central section of the traverse have a shallow apparent dip and in my opinion do not indicate the lithostratigraphic layering, given the steep dips on the surface. Rather, I believe that these reflectors are more likely to represent faults and that the section is viewing a cross-section of the thrust-stack in this region, which in cross-section appears to have the geometry of nested spoons. In the eastern part of the section there are numerous seismic artefacts creating a vertical zig-zag pattern.

- The western part of the section clearly displays three southwards dipping thrusts near the surface, the outcrop of two of which coincides with mapped thrusts just south and east of Zeehan. The easternmost of these three thrusts surfaces close to a zone of workings in the Bell Shale SE of Zeehan and along the western side of the Little Henty River (Fig. 5). These thrusts may be part of a pop-up related to the regional thrusting.

- There is no evidence for intrusive rocks in this section.

SEISMIC LINE ZF- Trial Harbour road, unsealed, to Zeehan

- The Heemskirk Granite, exposed in the far west, dips steeply below the thrust stack of Precambrian and Palaeozoic units, becoming more shallow in dip between depths of 0.6 and 1.0 seconds. At 1.8 seconds depth there is a clear, apparently west-dipping reflector or series of reflectors which appear overlain by the granite, which appears also to underlain this zone with an apparent

subhorizontal contact. Two interpretations are possible; either the granite has intruded a sequence of good reflectors which dip westward, or the upper part of the reflectors constitutes a post-Devonian, possibly Tertiary, thrust which dips westward and has a lateral throw of 3km. The rocks forming the reflective zone are unknown at the surface. Their clarity of reflection is consistent with this zone being a correlate of the thick Precambrian sedimentary rocks of NW Tasmania or possibly the Permo-Triassic Parmeener Supergroup. The latter consideration needs careful assessment as it has profound implications both for interpreting the regional structural history and for hydrocarbon exploration both offshore and onshore. This intriguing reflector is accessible to a deep drill-hole (minimum depth approximately 0.8 seconds or about 1.6km) possibly co-funded through a grant by government.

- The section confirms that the Heemskirk Granite, the purported source of mineralisation in the Zeehan district, may be no deeper than 1.1 seconds (approx. 2km) below Zeehan.

- The section down to 0.8 seconds consists of a series of thrusted Cambrian and Precambrian units individually identifiable only by surface mapping. In the section the thrusts appear to dip shallowly east, implying east-over-west movement. This is consistent with the geological map, which shows this region to lie on the western limb of a very broad synclinorium composed of nested, open spoon-like thrust sheets.

- In the Comstock Mine area, the 10th Legion Fault dips east and cuts the Balstrup Fault. Consideration of the geometry in the seismic section and the geological map suggests that the Balstrup Fault is the thrust sole of a fault-ramp anticline over-riding the 10th Legion Fault and up-arching the Cambrian sediments which further east underlie a very thin veneer (100-300m) of the Precambrian Oonah Formation. This implies that the Cambrian volcanic and mafic intrusive rocks series may also underlie this thin veneer of Oonah Formation. These Cambrian igneous rocks constitute an exploration target for nickel and cobalt (Fig.6).

- Between -0.5 and 0.2 seconds depth, there appears to be a shallowly dipping, elongate, lensoidal, seismically "dull" zone extending under the Comstock Mine area and to the east and west. This zone is cut by probable thrusts, although it is not offset to any great extent. There are no data bearing on what this might represent; I raise the question that this could be a Cambrian igneous body or possibly a thick zone of dolomite. It needs testing by drilling.

CONCLUSIONS

The structural geology of the ZEEHAN 1: 50 000 quadrangle is dominated by thin skinned tectonics which the seismic data show to consist of thrust-sheets as deep about 3000m.

The seismic data can be interpreted as indicating two sets of thrust systems, a system in the east of the Zeehan quadrangle juxtaposing the Cambrian and Ordovician series along a set of thrusts which may have been transported from the SE or east, and the

more prominent thrust system which includes the Precambrian to Devonian units and whose mapped geometry and seismic response is consistent with transport from the NW.

According to the surface mapping, the Devonian Heemskirk Granite post-dates the more prominent set of thrusting, but according to the seismic data could be cut by a reverse fault or thrust with a lateral displacement as great as 3km. Such a structure could be of post-Permian to Quaternary age and thus would be of importance to petroleum exploration.

The western part of the area studied contains a deep and prominent zone of reflectors; whilst there are various possible explanations for these, the possibility of these reflectors being formed of Permo-Triassic rocks can only be ruled out by unscientific prejudice, given the present information. It would be useful to test this idea further as it has important implications for both offshore and onshore petroleum exploration.

In the Comstock mine region, the seismic data coupled with surface mapping confirm that the Precambrian rocks form a very thin skin over Cambrian rocks prospective for nickel and cobalt.

The structure of the area south of Zeehan, as determined from the seismic data, is consistent with microgravity data held by Zeehan Zinc Pty Ltd indicating that the Cambrian volcanic and mafic/ultramafic series underlies the siliciclastic units forming Mt Zeehan (Fig. 6). That is, the nickeliferous rocks derived from small trenches immediately north of and below Mt Zeehan, close to the southern extension of the 10th Legion Fault, probably extend south under Mt Zeehan. In Figure 6 I have shown also the possible wider extent of nickeliferous mineralisation in the Cambrian series, as consistent with the seismic data which show the possibility of stacked thrust sheets down to possibly 3 000m depth, thus allowing considerable interthrusting between the Cambrian sedimentary and nickeliferous igneous rocks below the thin veneer of Precambrian Oonah Formation.

RECOMMENDATIONS

1) The seismic data show for the first time the likely extent and depth of the regional thrusting within the Zeehan mineral district, and also the style of thrusting and possible major thrusts. These data are of considerable benefit to industry now and in the future, and it is therefore reasonable to propose that my interpretations should be tested by a deep stratigraphic drilling programme allied to detailed geophysical studies. Such a study cannot be funded by one company alone, particularly as it would extend across lease boundaries. Therefore, I suggest that Zeehan Zinc Pty Ltd proposes to the Tasmanian Government that Mineral Resources Tasmania should conduct a carefully planned government–industry collaborative geophysical and stratigraphic drilling programme to enhance knowledge of the Zeehan mineral district and to test the possibility of Permo-Triassic rocks below the western part of the Zeehan region; the reverse fault of Permian rocks over the Oonah Formation, noted by Blissett and Gulline (1962) at the Montana Mine, has for too long remained an enigmatic anomaly.

2) Zeehan Zinc Pty Ltd should include in its focus drilling for nickel below the Oonah Formation, below the Ordovician siliciclastic units of Mt Zeehan and below the Cambrian sedimentary rocks both in the Zeehan area and also in the region north of the Balstrup Fault. Careful study of the previous micro-gravity mapping could help targetting for mafic/ultramafic rocks hosting nickel.

3) The recognition from the seismic data that the Zeehan area is underlain by stacked thrusts to a depth of possibly 3000m means that the Gordon Limestone, held to be a host for SEDEX mineralisation, will be very widespread sub-surface and may even underlie the Oonah Formation. Gordon Limestone is reported along the Dunkley tramway north of Zeehan and here may very well underlie the Oonah Formation very shallowly. Areas where the Gordon Limestone are cut off by faults against other rocks thus remain targets as the limestone may well be found at mineable depths in the faults' footwalls.

4) Surface exposures of the Gordon Limestone contain bitumen. The recognition of the area as constructed of stacked thrusts as deep as 3000m may well have implications for on-shore hydrocarbon exploration. Thus deep stratigraphic drilling by the Tasmanian Government could well be beneficial.

5) Zeehan Zinc Pty Ltd has drilled a number of deep drill-holes to about between 600m vertical depth. Although these holes are not in the plane of the seismic sections and their maximum vertical depth is no greater than 0.3 seconds and thus their detailed information is resolvable on the scale of the seismic sections, my brief examination of the drill-logs leads me to the opinion that these holes are indeed valuable in that it is possible to construct simple, graphical 3-point solutions to determine the depth and dip of the 10th Legion Fault immediately under the Comstock Mine. The sections also highlight rapid changes in thickness of the dolomitic units in the Oonah Formation, and again 3-point graphical constructions can be used to determine the depths and dips of these bodies. I recommend that Zeehan Zinc Pty Ltd analyse these drill-hole data accordingly; the termination of funding prevented me from doing so.

REFERENCES

Blissett, A.H.; Gulline, A.B. 1962: One mile geological map series K/55-5-50 Zeehan. Department of e Mines, Tasmania.

Findlay, R. H. 1993: Summary of structural and stratigraphic observations on the Proterozoic/Eocambrian/Cambrian units of the Zeehan 1:50 000 quadrangle. Mineral Resources Tasmania Report 1993/29.

Findlay, R.H.; Brown A.V. 1992: The 10th Legion Thrust, Zeehan district; distribution, interpretation and regional significance. Report of the Department of the Tasmania Mines, 1992/02.

McClennaghan, M.P.; Findlay, R.H. 1993: Geological Survey Explanatory Report , Sheet 64(7913S), Macquarie Harbour. Division of Mines, Tasmania Department of Development and Resources.

Stacey, A.R.; Berry, R.F. 2004: The structural history of Tasmania: a review for petroleum explorers. PRESA Eastern Australasian Basins Symposium II, Adelaide: 151-181.