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Old Data, Changed Times, New Resource? A Case Study, Barrytown, New Zealand, Ilmenite Garnet Gold Zircon

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SUMMARY

The project geology has been compiled reviewed and a new, modern, resource database has been developed for the Barrytown New Zealand, Ilmenite Garnet Gold Zircon project.

The work required existing databases to be updated to include all historic mineral sands and gold data, and consolidated and checked versus original records.

The NZ Petroleum and Minerals (NZPAM) Mineral Report (MR) documents for the Barrytown project were checked and the data was compared to that contained in the project databases compiled prior to this recent 2018 work. Additional information was extracted and added into the databases including omitted holes, collars, size fractions, magnetic fractions, lithology, and especially gold assays. Within the project budget, as much additional data as could possibly be extracted was found by being persistent and systematically working through the contained information. The NZPAM system, although not ideal, does contain a wealth of information.

Key words: Barrytown, database, ilmenite, garnet, gold

INTRODUCTION

The Barrytown heavy mineral sand deposit has been investigated and partly mined for gold since the 1930s. Other than gold, the deposit contains ilmenite, garnet, and zircon all at levels of economic interest.

The recently undertaken estimation process required that the existing databases be updated into a modern relational database to include all available historic mineral sands data and consolidated and checked versus original records. Upon completion of the database, resource estimates were prepared for the ilmenite content of the sands. The resource estimates are reported under the 2012 JORC Code guidelines. Garnet and zircon were also reported but at an Exploration Target classification due to the lack of sufficient data.

The Barrytown mineral sand deposit is located approximately 29 km north of the regional centre of Greymouth on the West Coast of the South Island of New Zealand. The coastal plain (‘Barrytown Flats’) is an elongate area approximately 17 km long N-S by 2 km E-W, flanked to the east by the Paparoa Ranges and to the west by the Tasman Sea.

Most of the area has an elevation of less than 20 m above sea level and is backed along the eastern side by steep slopes along an old sea cliff. The area is drained by a number of creeks originating in the Paparoa Ranges and draining westward into the Tasman Sea. The flats comprise a series of prograded marine beach strandlines and low sand dune deposits that enclose topographically low swampy areas. Much of the land has been drained and is used for farming.

The area has been historically of interest for gold. The earliest mining dates back to 1867 when the first rush occurred in the Canoe Creek area. More recently exploration was conducted by NZ Gold Options (1931-32), NZ Prospecting and Mining Ltd (1935-37), Whites Electric Dredging Company (1936-41), and Barrytown Dredging Company Ltd (1937-45), and the Flats were mined by dredging in the southern part of the permit area up until the 1940s.

In later years, 1966 through to 2000, ilmenite was the objective of exploration and mining proposals, with Carpentaria Exploration Company, Mineral Resources (NZ) Ltd and Amax Exploration NZ Ltd, Fletcher Titanium Products Ltd, and North Broken Hill Peko Limited, having completed assessment work. Rio Tinto Ltd acquired North Ltd and all its assets, including the Barrytown project and the company Westland Ilmenite Ltd, in August 2000.

GEOLOGICAL SETTING

The Barrytown Flats contain a series of Quaternary shorelines and local alluvial fan deposits that have in places been obscured by historic gold mining activities, particularly in the south. Suggate (1989) says that since 1951 there are documented active shoreline retreats of up to 40m in the south and advances of 30m in the north, and considered that the present shoreline had formed within the past 1000 years.

The regional geology shows the change in basement rock type to the east of the Barrytown Flats. To the north of Canoe Fault, the pre-Quaternary hills are composed of soft Tertiary sediments that were easily eroded by high Pleistocene sea levels and remnants of related raised beaches are found at elevations of up to 120m. South of the Canoe Fault, granitic rocks of the Carboniferous Karamea intrusive suite and metasediments of the late Palaeozoic Greenland Group form a more resistant basement with steep hills along the eastern boundary to the beach deposits. Here local fan deposits formed covering parts of the coastal deposits as a result of large volumes of more resistant eroded material bought down by the steep streams and these fans may be up to 30 m in thickness.

According to Newman (1989), much of the detritus forming the Barrytown mineralised deposits are derived from rivers entering the sea further to the south and this has been transported north by longshore drift, and then been sorted to produce deposits of predominantly fine sand.

Barrytown Flats Geology

The Barrytown flats have developed from coastal progradation as a result of an offshore northerly longshore drift with deposition of sediment between the ocean and the inland post-glacial cliff that defines the eastern limit of the deposits.

Suggate (1989) described the Quaternary beach deposits and identified three sequences of separate shorelines, distinguished on the basis of aerial photograph interpretation, topographic maps, and ilmenite sand drilling results.

Mineral Deposits

The Barrytown Flats contain marine placer mineral concentrations of ilmenite, garnet, zircon, gold, and associated heavy minerals. The mineral bearing sands are concentrated into a series of strand lines developed along, and behind, the present beachfront in sandy barriers transported by longshore drift and pushed up from the sea by wave action. These sandy barrier deposits have become stranded as the coastline prograded and allowed lagoonal deposits to accumulate in the swales along the eastern side of the barriers. This has had the effect of elongate higher-grade zones on the former beaches being surrounded by lower grade finer sands and silty sediments in the swales.

Heavy minerals are concentrated by wave action into lensoidal shaped bodies which have formed on the beach and extend along the length of the beach. They therefore follow the dip of the beach towards the sea at about 5° to 10°. Each mineralised body comprises a sequence of fine sand laminations of heavier and lighter minerals. Where strong storm concentrations occur, the dark heavy layers can coalesce with only minimal, or no, interbedded paler light mineral laminations within the sediments deposited during that storm episode and this can be observed in places along the high-grade eastern strandline.

The gold occurring in the flats is typical of the West Coast beach deposits that contain essentially reworked detrital gold being continuously washed downstream by the rivers and reconcentrated in the active surf zone together with the other heavy minerals, such as ilmenite and garnet, in lenticular 'black sand leads. This form of gold is generally very fine-grained and may be difficult to recover by traditional gravity concentration methods.

Ilmenite, garnet, and associated minerals are considered to have been derived mainly from the Haast Schist terrane to the east of the Alpine Fault (Nathan et al., 2002).

Mineralogy

The main economic minerals in the Barrytown deposit have the properties listed below.

Ilmenite: A significant portion of the ilmenite occurs as composite or aggregated grains with attachments of other minerals, mainly quartz and feldspars.

Garnet: Almandine occurs as the dominant garnet species in the deposit and is the garnet most frequently used for industrial applications. The properties that make garnet useful for abrasive and other applications are its high melting point (1250°C), sharp sub-rounded to sub-angular chisel edge fracture, low free silica content, and the high resistance to physical and chemical attack

Zircon: Is a very small component, typically concentrated with the ilmenite and garnet in the sands.

Gold: Barrytown gold occurs as fine-grained flakes.

The heavy minerals (SG >2.9) listed below were determined for the 6.4 amp magnetic fraction from composited samples of holes NBHP8 and 9 and holes NBHP12 and 13 and reported in Lee (1989). The results presented in Table 1 are a valuable guide to the overall in situ garnet content of the Barrytown sands.

Table 1. 6.4 Amp Magnetic Fraction Mineralogy

Drill Holes	NBHP8 & 9	NBHP12 & 13
	% In Raw Sand	% In Raw Sand
Ilmenite	21.9	9.4
Garnet	23.6	12.7
Silicates*	2.9	4.5
Composite particles	5.8	11.9
Epidote	2.3	1.6
Other mags	1.2	0.8

* *Silicates are mainly pyroxenes, amphiboles, biotite, and chlorite*

HISTORY OF PREVIOUS MINING AND EXPLORATION

Carpentaria Exploration Company, (Mount Isa Mines Ltd), conducted the first detailed exploration program and produced ilmenite, zircon and monazite products in a pilot separation plant. In 1980, Mineral Resources (NZ) Limited and Amax Exploration (NZ) Inc jointly held the ground and reviewed the historic database. In 1982, they formed a joint venture with Grampian Mining Co (which later became Fletcher Titanium Products Ltd) to investigate the TiO_2 potential of the resource. Fletcher's built a pilot plant on site in about 1986. In 1989, Westland Ilmenite conducted infill resource drilling, and bulk test pitting in the northern part of the deposit, followed by trial mining.

The Barrytown area has been the subject of a number of drilling programs since the 1930s including:

- New Zealand Gold Options (1933-1934); 40 holes sampled for gold (not documented).
- New Zealand Prospecting and Mining (1936-1937); 570 holes sampled for gold.
- Barrytown Dredging Company (1937-1938); 27 holes.
- Carpentaria Exploration Company (1966-1973); 531 holes.
- Grampian Mining Company (1985-1986); drilled 136 holes.
- North Broken Hill Peko/Westland Ilmenite; 820 holes.

Ilmenite Character

Burgess (1989) described the characteristics of the ilmenite deposit to include:

- TiO_2 levels ≈47% and high $FeO:Fe_2O_3$ ratios
- High SiO_2, Al_2O_3, CaO and P_2O_5 levels
- composite nature of the ilmenite due to its metamorphic origin.

Barrytown Garnet Character

Garnet has been detected in many samples collected from the Barrytown deposit, especially in work conducted since 2010 which was targeting garnet as a potential revenue stream for the project. Almost all of the garnet work to date has been directed towards establishing the separation characteristics and the quality of this mineral for industrial applications. However, little systematic garnet quantification work has been carried out to assist in determining the grade and distribution of garnet throughout the deposit, and therefore only limited data is available upon which can assist with understanding resources.

From the garnet studies undertaken by the joint venture partners in the past five years at Barrytown it is apparent that a marketable almandine garnet is potentially available from the heavy mineral bearing sands. More investigation is required in order to quantify the grade and distribution throughout the deposit, while Figure 1 shows graphically shows garnet liberation results obtained from work completed by the Barrytown Joint Venture in recent years.

DATABASE

In order to report the Barrytown mineral sands under JORC 2012, the project database needed to be compiled, restructured and checked from historical and more recent work.

From the historical data, the Mineral Report (MR) Series documents for the Barrytown Ilmenite Project lodged with NZ Petroleum and Minerals (NZPAM, at the time, New Zealand Ministry of Economic Development) were of particular use. These 'MR' documents ranged from 1932 to 2001. A lot of the historical data for the project had been captured or partly captured by recent, circa 2013-14, work but a substantial amount of information, notably gold data, was only re-discovered during the 2018 resource modelling work. This substantially added to the understanding of what exploration work for gold had actually been carried out and allowed for the modelling of gold.

The outcome of the trawling through the NZPAM MR reports was the compilation of more complete, modern day, drilling database comprising ilmenite and gold sampling and assaying. The most important outcome of this process was the construction of a new 'size fraction' table containing logged sampled intervals that record the mineralised sand information data such as dry weight, heavy mineral size fractions and contents.

The proportion of garnet within the size fraction sampling data table is not known because garnet determination information was not historically recorded for the majority of the pre-2013 holes. Because of the lack of data for garnet in the size fraction table, modelling of garnet was not carried out during the estimation process.

Interpreted Geological Surfaces and Resource Modelling

With the database having historical data added and being constructed to modern standards, it allowed for the 3D interpretation of geological surfaces, such as 'bottom of over-burden', 'bottom of possible mineralised sand' and 'rising sand limit' surfaces. The 'bottom of mineralised sand' is interpreted to be the possible lower limit of where mineralised sand could occur and serves as a lower base for the block modelling process.

Gold, Garnet and Zircon Data

As noted in the Database section above, when the authors were compiling data for the ilmenite resource work, it was discovered two NZPAM reports containing information on gold had been overlooked in the recent past. This data was added to the database by way of digitising the circa 1980 maps. The authors were able to extract 799 holes with gold information from this re-discovered report.

RESOURCE ESTIMATION

Ilmenite

Ilmenite resources were estimated using the Ordinary Kriging estimation technique. The block model was flagged with the geological interpretation surfaces and block fraction codes were applied to the model: 'below overburden', 'above base of mineralised sand' and 'topography'. Estimates for density were determined by using the relationship between ilmenite grade and bulk density.

Along with the estimates of ilmenite and density, the rising sand (hydraulically fluidised) parameter was also estimated on an indicator basis, i.e. the proportion of the block that is informed by samples without/with a rising sand issue during exploration drilling. This indicator was then used in the resource classification scheme. Rising sand typically produces large drill hole samples of lower grade, due to the dilution of the heavy minerals with lower density silicates minerals.

Although the authors developed a resource model for ilmenite, the resources have not yet been publicly reported and thus, per VALMIN and JORC requirements, we are not permitted to include them here. However, a generalised plan of the block model at a single topographic level (flitch) illustrating the estimated distribution of ilmenite is shown in Figure 2. This illustrates how the grades observed in the data have been modelled to reflect the variation from location to location within the deposit; and change according to many factors controlling the original deposition of ilmenite, plus other heavy minerals (gold/garnet/zircon) in the beach shoreline environment.

Garnet and Zircon

Based on limited sampling and quantification of zircon and garnet during the exploration of the Barrytown mineral sand deposit the following suggested ratios are:

- ilmenite:zircon ranging between ~132:1 and ~37:1
- ilmenite:garnet ranging between ~1:1 and ~0.67:1.0

The amount of information and data quantifying the zircon, and especially garnet, is lacking to the extent that mineral resource estimates cannot be carried out for them. However, in accordance with the JORC 2012 code, the authors where able define, provided certain reporting requirements are met, zircon and garnet in terms of an Exploration Target. This Exploration Target has not yet been publicly reported and, per VALMIN and JORC requirements, we are not permitted to include them here.

Gold

As noted in the Database section above, when the authors were compiling data for the ilmenite resource work, it was discovered that two NZPAM reports containing information on gold. Although this was a significant find, there were issues with the gold data, to the point that the authors could only develop a model to the level of an Exploration Target model for gold under JORC 2012.

CONCLUSIONS

Based on the geological information now compiled and the newly constructed database which has been prepared, new resource estimates for the project can be prepared taking into account a larger body of information than has previously been available.

These estimates will be used for planning and future exploration targeting with a view to developing a viable multi-commodity mineral sands project based on the Barrytown resources.

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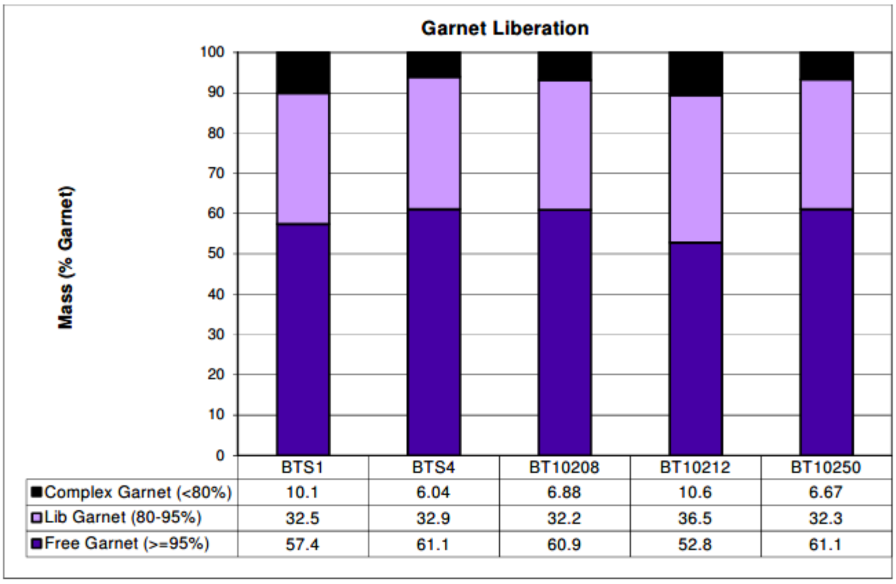

Normalized Mass of Garnet Across Samples

Mineral Name	BTS1	BTS4	BT10208	BT10212	BT10250
Free Garnet (>=95%)	57.4	61.1	60.9	52.8	61.1
Lib Garnet (80-95%)	32.5	32.9	32.2	36.5	32.3
Complex Garnet (<80%)	10.1	6.04	6.88	10.6	6.67
Total	100.0	100.0	100.0	100.0	100.0

Figure 1. Garnet liberation for five Barrytown samples.

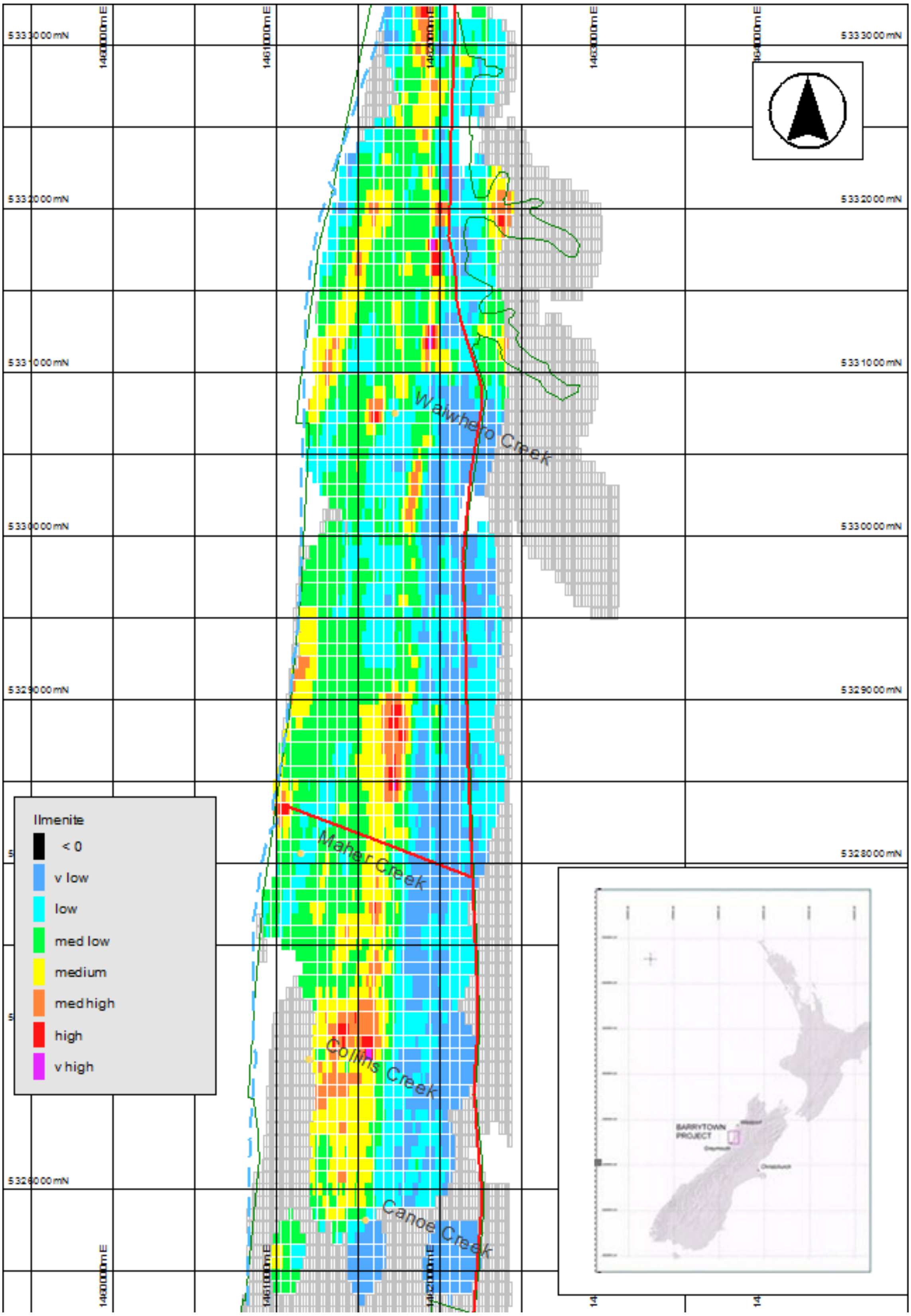

Figure 2. Generalised plan of the block model illustrating the estimated distribution of ilmenite.