COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS

RECORDS NO. 1964/58

SURVEY OF MINERAL RESOURCES IN NEW SOUTH WALES

TAILINGS DUMPS

BY

R.W.L. KING

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SUMMARY

Sampling of selected tailings dumps in N.S.W. was followed by radioactive, spectrographic and chemical analysis of samples for the less common elements. Certain samples were selected for mineragraphic examination. However, none of this work revealed unsuspected potential for valuable elements in economically useful quantities. Further work by the Bureau is not recommended for the dumps examined.

INTRODUCTION

The purpose of the survey was :

(i) to disclose possible sources of the less common metals which at present are coming into prominence for such purposes as structural materials in nuclear engineering, in alloys of superior performance at high temperatures, and for high purity metals and alloys with particular electronic properties;

(ii) to indicate dumps which, by reason of their size and metal content, may warrent re-treatment because of factors such as improved mineral dressing techniques, improved metal prices, or the presence of metals of newly acquired importance mentioned in (i) above;

(iii) to discover sources of metals which would not in the past have expected in certain types of deposit, but are now known to be sometimes found in them.

It is intended that this survey of mineral resources in tailings dumps should be extended progressively to cover the whole of Australia. The survey of N.S.W. dumps was of an exploratory nature to develop techniques of sampling, surveying, analysis of samples, and presentation and evaluation of results.

SCOPE OF SURVEY

The deposits selected for the survey were chosen following reference to the New South Wales Mines Department, examination of some general references, and discussions with individual district Inspectors of Mines. Selection was based on size of dump and complexity of mineralization, together with the consideration of obtaining a representative cover of mining areas in the State.

The analytical work on samples was carried out by the Australian Mineral Development Laboratories. It included a qualitative assessment of radioactivity and spectrographic analysis for a large number of elements other than phosphorus and the following ones commonly present in rocks: silicon, aluminium, iron, magnosium, calcium, sodium, potassium, and titanium. The limits of detection of the spectrographic method for the various elements to which it is sensitive are set out in Appendix I. Chemical analysis was used for sulphur and selenium. Detection limits were selenium one part and sulphur fifty parts per million respectively.

In the case of the Captain's Flat sample, which was analyzed after the others, the test for selenium was less sensitive and reported by A.M.D.L. as ten parts per million. It was carried out by X-ray fluorescence.

METHOD OF SAMPLING

Samples from small dumps not associated with large operating mines were collected during May 1962. Erosion had exposed reasonable sections through the majority of dumps and the samples were taken by shovel from a number of places some distance below the eroded dump surface. In other cases a small hand auger with extension handle was used.

Areas of dumps were measured by pacing and compass surveys and heights by tape and clinometer. In a number of cases the presence of slag dumps from old smelters was noted and though these dumps were not sampled, a rough estimate of size was made in each case. In calculations factors of 20 cu. ft. = 1 ton for sand and slime and 15 cu. ft. = 1 ton for slag were used. Because the slope and shape of the ground surface beneath the dumps was not known in most cases, tonnage estimates are very rough and should be regarded as giving only the general order of size.

Dumps associated with large operating mines were sampled by the operating companies, who supplied estimates of the tonnages represented by the samples forwarded.

Each sample was about five pounds in weight and was subsequently divided into two roughly equal portions. One portion was used for the spectrographic, chemical and radioactive tests, while the second portion was retained for further examination if this was considered warranted by the analytical results and the size of the dump represented by the sample.

RESULTS BY DEPOSITS

The semi-quantitative spectrographic measurements made on each sample are set out below, together with a description of the location of the mine area, the samples taken and tonnages represented thereby. At the end of this Record, (Appendix IV) detail sheets set out the results for all elements detected but not determined more closely than within the ranges of major (10-100%), minor (1-10%), heavy trace (0.1-1%), trace (0.10-0.1%), faint trace (0.001-0.01%) and very faint trace (0.0001-0.001%).

The results are set out in the order in which dumps were sampled in May 1962, and correspond in groups with the various Mines Inspectors' Districts. Dumps sampled by operating companies are set out after the groups sampled in May 1962.

Orange Inspector's District

Burraga

The mine is reached by a road which branches off to the right after crossing the first creek on the Burraga - Porter's Retreat road, about ¼ mile beyond the town. This branch road follows the creek downstream and leads to the mine.

The slag dump is reached first and lies between the road and the creek. The quantity of slag was roughly estimated as being over 50,000 tons. Further downstream the main sand dump is visible from the road and extends downhill toward the creek from the old mill foundations. All samples were taken from the main dump which was spread out over the slope of the hill. Estimation of tonnage was difficult because of the irregular shape of the dump, but it could exceed 40,000 tons.

Sample No. 1 was taken from a hand auger hole in the top centre portion of the dump and consisted principally of grey sand with small amounts of yellow and black sand. Elements measured were copper 2.5%, zinc 0.15%, manganese 0.1%, rubidium 0.02%, lithium 0.02%, scandium 0.009%, silver 0.001%.

Sample No. 2 was sand, taken from an auger hole 4 feet deep in the bed of a gully in the north face of the dump, halfway down the upper portion of the dump. Elements measured were copper 2.0%, zinc 0.25%, barium 0.15%, manganese 0.1%, rubidium 0.03%, scandium 0.007%.

Sample No. 3 was of slime projecting from the foot of the sands on the west side. Elements measured were copper 2.0%, zinc 0.1%, rubidium 0.035%, lithium 0.02%, scandium 0.008%.

Sample No. 4 was of black sandy material from the head of the gully in the north face of the dump. Elements measured were copper 2.5%, zinc 0.4%, barium 0.25%, manganese 0.15%, rubidium 0.04%, scandium 0.004%, silver 0.001%.

Copper seems to be the only element likely to be of economic significance. Blaskett (1957) reported on the recovery of copper from this dump. He stated that the head value of the sample supplied was 0.9% copper, and that the company forwarding the sample considered that several hundred thousand tons of material was available for treatment. Blaskett suggested treatment methods for sands ~~in~~ and slimes as a result of his tests.

Junction Reefs

The mine area is reached by following a signposted turn off from the Burnt Yards - Mandurama road. The track continues on beyond the end of the formed road to the north bank of the Belubela river. Access to the south bank area is blocked by a broken causeway across the river, but it should be possible to reach the southern area easily by road through "Sunny Ridge", a property ½ mile beyond Mandurama on the Canowindra road.

It appears that ore from the north bank deposits was mostly from underground workings, (the Sulphide Mine) while that from the south bank deposits was from open cuts (Grant's Open Cut and Sheahan's Mine).

Sample No. 1 was taken from the top centre portion of the upper dump at the Sulphide Mine. Elements measured were arsenic 0.4%, manganese 0.4%, rubidium 0.03%, scandium 0.0012%.

Sample No. 2 was taken from both walls of a gully cut through the top of the upper dump. Elements measured were arsenic 0.9%, manganese 0.25% and rubidium 0.04%.

Sample No. 3 was taken from a small gully in the lower dump. Elements measured were arsenic 0.6%, manganese 0.2%, rubidium 0.04% and scandium 0.0015%.

Sample No. 4 was taken from two auger holes each 2 ft. 3 ins. deep in the western of three main dumps and a fringing riverside dump on the southern side of the Belubela River. Elements measured were arsenic 1.2%, rubidium 0.03%, scandium 0.002%.

Sample No. 5 was taken from 2 auger holes, 2 ft. 3 ins. deep in corners of the centre dump. Elements measured were arsenic 2.0%, rubidium 0.03% and scandium 0.002%.

The first three samples represent two dumps joined together containing perhaps 5,000 tons. The last two samples represent a total of 10,000 tons in the four dumps.

Dumps were particularly hard and consolidated probably due to the original ore containing large amounts of iron sulphides, including pyrrhotite. Some study of these dumps may be warranted by anyone interested in the consolidation of mill tailings as mine fill.

This same feature of consolidation would increase the cost of retreatment for recovery of any contained gold. However, no traces of gold were noted in the spectrographic analysis.

Further work on these dumps by the Bureau does not seem warranted at the present time. Henderson, (1953) gave a general description of the deposits and operations carried out in this district. Little work has been carried out since that time.

London Mine, Parkes

Dumps between the railway line and Woodward Street, near Keast Street and at the Bushman mine situated to the N.N.W. of the Memorial Tower, were examined but not sampled. Local residents advised that they had been retreated at least once. The most recently operated mine was the London, situated 1½-2 miles beyond the golf course to the left of the road travelling away from Parkes. The turn off is situated opposite a gateway with a ruined house at the top of the hill beyond it. Some mine workings are visible from the main road, but the dump itself is obscured by a low hill.

The sample was taken from the walls of many small gullies which cut into the large dump. Elements measured were manganese 0.4%, barium 0.2%, rubidium 0.15%, lithium 0.04%, scandium 0.02%, yttrium 0.01%.

The dump was estimated to contain 6,000 tons. No further investigation is warranted on the basis of the results obtained.

Peak Hill

Extensive sand and slime dumps are situated adjacent to the main road between Peak Hill and Tomingley near McPhail. The slime dumps are situated to the east, the sands to the west near the shaft, and the two areas are separated by the remains of a cyanide plant.

Sample No. 1 was made up of many grab samples from the walls of gullies in the slime section and represented about 70,000 tons. Elements measured were arsenic 0.1%, rubidium 0.05%, scandium 0.015%.

Sample No. 2 was taken from the north west edge of the sand dump from which material for retreatment has been removed. There is approximately 90,000 tons of sand in this dump. The only element measured was scandium 0.003%.

The sand is apparently removed occasionally for construction purposes. This seems the best use that could be made of the material in this area.

Mt. Hope

The mine is situated on the crest of the hill on the right as one enters the town from Condobolin. The tailings dumps are situated on the slope of this hill away from the town.

Sample No. 1 was taken from gullies in the south face of the southerly dump. The element measured was copper, 3.0%.

Sample No. 2 was from the gullies in the north east face of the same dump, which was estimated to contain 5,000 tons. Elements measured were copper 0.9%, rubidium 0.01% and scandium 0.0012%.

Sample No. 3 was from gullies in the south west face of the northern dump. Elements measured were copper 1.1% and scandium 0.0025%.

Sample No. 4 was from the large gully in the east face of the same dump which was estimated to contain 7-10,000 tons. Elements measured were copper 0.4%, arsenic 0.05% and scandium 0.0012%.

Sample No. 5 was taken from tailings from the slag retreatment plant. The dump was estimated to contain 600 tons, and the elements measured were copper 3.0%, manganese 0.1%, lanthanum 0.08%, neodymium 0.05%, rubidium 0.05%, yttrium 0.02% and scandium 0.004%. This dump is adjacent to the main street and north of the main slag dump, which was estimated to contain 20,000 tons.

The only element of interest in these dumps is copper, and it occurs in relatively small quantities. No further work by the Bureau is warranted at this stage.

Mt. Royal Mine, Tottenham

This mine is located adjacent to the Nyngan road on the left hand side just after crossing the railway line. The sand dump is washed out and distributed over a large area, and averages only 18 inches thick. The thickest portion is 4 ft. 6 ins. Total tonnage is estimated at 2,500.

Sample No. 1 was taken from three short auger holes on the western edge of the dump. Elements measured were: copper 0.15%, arsenic 0.25%, rubidium 0.02%.

Sample No. 2 was from two auger holes in the centre of the thicker portion of the dump and consisted of reddish material. Elements measured were copper 0.15%, arsenic 0.1%, rubidium 0.025%.

Sample No. 3 was of grey material from the same portion of the dump. Elements measured were copper 0.5%, arsenic 0.06%, rubidium 0.015%.

The slag dump adjacent to the mine was measured and estimated to contain 10,000 tons.

Mineral Hill

Small dumps are located at the treatment plant which is situated at the northern end of the open space used as an airstrip. The turn-off from the main road is signposted, and at the time the area was visited a small sawmill was operating at the southern edge of the airstrip. Tailings from the Iodide mine treatment plant have all been used as mine filling in the Red Terror mine, and are no longer available on the surface for sampling and retreatment.

The treatment plant has operated on oxidised copper ore and tailings have been dumped in an area in heaps of reddish and greyish coloured sands. Sample No. 1 was taken from reddish material, probably from the Red Terror Mine. Elements measured were lead 1.5%, copper 0.7% zinc 0.25%, antimony 0.25%, arsenic 0.1% and silver 0.04% (equivalent to 14 ozs. per ton).

Sample No. 2 was of greyish material, probably from Block 9 mine. Elements measured were lead 10.0%, copper 1.2%, antimony 0.5%, zinc 0.3%, arsenic 0.15% and silver 0.03% (equivalent to 10 ozs. per ton).

The total quantity of material in the dumps was estimated as 1,500 tons. Although values in silver, copper and lead were high enough to be interesting and some germanium was detected, the small tonnage of material available does not justify further work by the Bureau.

Bobadah

The dumps sampled in this area are at the Overflow mine. Workings are visible from the Tottenham road, on the left hand side, about half a mile beyond the township.

Sample No. 1 was composed of grab samples of gully walls in the larger dump, which was estimated to contain 4,000 tons. Elements measured were lead 2.0%. copper 0.4%, zinc 0.2%, antimony and arsenic both 0.015%, silver 0.002% and scandium 0.0015%.

Sample No. 2 was from the smaller dump, about $\frac{1}{4}$ the size of the larger one and located nearer the shaft. This sample was of the slime material and elements measured were lead 4.0%, copper 0.7%, zinc 0.2%, rubidium 0.05%, antimony 0.01%, scandium 0.005%.

Sample No. 3 was of sandy material from the smaller dump. Elements measured were lead 5.0%, copper 0.75%, zinc 0.3%, rubidium 0.01% silver 0.01%.

Although the lead content of the dumps is significant, the total tonnage of material available is too small to warrant further work.

Nymagee

There are no treatment plant dumps at this centre, but at the time of the survey the old mine near the town was being prepared for leaching to recover copper. There are two slag dumps adjacent to the mine, one containing an estimated 50,000 tons is alleged to come from a water jacketed (blast) furnace. The other is alleged to contain reverberatory furnace slag, apparently somewhat contaminated with ash, and difficult to estimate, but possibly containing 10,000 tons of slag.

Sample No. 1 was taken from flue dust present in the old smelter stack flue, adjacent to the shaft (the Main Shaft) through which the rising main of the copper leaching system was placed. Grab samples were taken from several places on the face of the exposed heap of dust, and combined. Elements measured were copper 3.0%, lead 0.6%, zinc 0.2%, rubidium 0.07%, arsenic 0.05%, cesium 0.01%. The quantity of flue dust available for treatment was not measured, but is not likely to be large enough to warrant further research work at present on the basis of the analytical results above.

Crowl Creek Mine, Shuttleton

The mine area is on the west side of a ridge about one mile from the cross road running from Keighran's Tank to a point on the Gilgunnia - Cobar road seven miles south of Priory Tank. The mine turn off is also that to the homestead of Mr. L. Betts (which is visible to the left of the road travelling from Nymagee) and to the tennis courts built on the site of the old Shuttleton township.

These tennis courts are on the eastern slope of a ridge, and the mine, lying on the western slope of this ridge, is reached by a track turning off to the right between the branch track to Bett's homestead and the tennis courts.

The dumps sampled were adjacent to the old mine workings, and in the oxidised copper section of the dumps some boreholes were seen indicating that some interest had recently been taken in them.

Sample No. 1 was taken from the slime dump, and elements measured were copper 4.0%, rubidium 0.05%, lithium 0.025%, yttrium 0.02% and scandium 0.008%. The dump was estimated to contain 1,500 tons.

Sample No. 2 was taken from oxidised copper ore tailings in the main dump. These were distinguished from the sulphide ore tailings by their lighter colour, and might amount to one quarter of the estimated 3,500 tons in the dump. Elements measured were copper 7.5%, rubidium 0.08%, yttrium 0.015% and scandium 0.003%. This material might be usable for trace element fertilizer manufacture.

Sample No. 3 was from sulphide ore tailings making up the greater portion of the dump and elements measured were copper 0.3%, manganese 0.1%, rubidium 0.07%, lithium 0.04% and scandium 0.005%.

The slag dump was estimated to contain 50-60,000 tons of material, but was not sampled.

Copper appears to be the only element of interest, and even then only in the oxidised portion of the dump. The quantity of material is too small to justify further research work, but oxidised tailings might be saleable to manufacturers of fertilizer for the copper content.

Canbelego

The dumps are clearly visible from the township, the largest one being prominent as it stands 50 feet high in an area of gently undulating country.

Samples 1 to 3 were taken from gullies in the washed out face of this large dump. Sample No. 1 was from the top section, generally brown in colour and estimated to contain a total of 70,000 tons. Elements measured were zinc 0.5%, lead 0.18%, manganese 0.1%, rubidium 0.1%, lithium 0.04% and scandium 0.003%.

Sample No. 2 was from the centre section of the large dump and was principally grey in colour. It was estimated that this section contained approximately 38,000 tons. Elements measured were zinc 0.8%, rubidium 0.06%, lithium 0.04%, arsenic 0.02%, antimony 0.01% and scandium 0.003 %.

Sample No. 3 was taken from the bottom section of the large dump and was predominantly pink in colour, but with some red, grey and green material also. It was estimated to contain 117,000 tons approximately. Elements measured in this sample were zinc 0.5%, rubidium 0.05%, arsenic 0.015% and scandium 0.003%.

Two smaller dumps, possibly containing tailings from retreatment of the larger dump, are situated to the north-north-west. Sample No. 4 was taken from the smaller of these dumps which was estimated to contain 14,000 tons. Elements measured were zinc 0.4%, lead 0.15%, manganese 0.1%, rubidium 0.1%, lithium 0.03% and scandium 0.003%.

Sample No. 5 was from the larger dump, estimated to contain 22,000 tons. Elements measured in this sample were zinc 0.7%, lead 0.3%, barium 0.15%, rubidium 0.12%, arsenic 0.05%, lithium 0.04% and scandium 0.003%.

Girilambone

At the time of the survey a contractor was crushing slag for use as railway ballast, and the Main Roads Board was considering the use of some dump material for road construction. The workings are visible to the right of the Hermidale road, about two miles out of town.

Sample No. 1 was from the pink coloured dump due north of the most south easterly dump. The pink dump was estimated to contain 1,500 tons. Elements measured were copper 4.0%, yttrium 0.015%, rubidium 0.01%, and scandium 0.007%.

Sample No. 2 was from the south eastern dump, apparently composed of sands and jig tailings from sulphide ore. The dump was estimated to contain 2,000 tons of material. Elements measured were copper 0.75%, arsenic 0.04%, yttrium 0.015%, scandium 0.005%.

Sample No. 3 was from the main dump containing some oxidised ore. Estimated tonnage was 10,000 tons, and elements measured were copper 0.4%, arsenic 0.025% and scandium 0.0025%.

Sample No. 4 was from the pink slime dump to the south west of the main dump. This was estimated to contain 3,500 tons and elements measured were copper 0.8%, rubidium 0.01%, arsenic 0.01% and scandium 0.005%.

Copper is the only element present in important quantities, but the limited amount of material does not warrant further research work at this stage.

Bodangora

The workings and dumps are clearly visible to the left of the road to the Bodangora Post Office which turns left from the main road to Gulgong about six miles out of Wellington. There are remains of a stamp battery at the top of the hill, several large mullock dumps and a brick chimney stack.

Sample No. 1 was from the large dump at the foot of the hill, estimated to contain 70,000 tons. Sand from this dump is apparently removed for construction purposes (plaster sand), from time to time. Elements measured were copper 0.3%, lead and zinc both 0.2%, tungsten 0.03%, antimony and arsenic both 0.02%, rubidium 0.015% and scandium 0.003%.

Sample No. 2 was from the dump of slimes adjacent to the large dump and on the north side of it, near the old mill foundations. Tonnage was estimated at 1,500 and elements measured were copper 0.5%, lead 0.5%, zinc 0.25%, tungsten 0.08%, arsenic 0.05%, antimony 0.01%, scandium 0.006% and silver 0.001%.

Sample No. 3 was from a dump further up the hill and to the east of the remains of the retreatment plant. Tonnage was estimated at 12,000 tons, and elements measured were copper and zinc 0.5%, lead 0.3%, rubidium, arsenic and antimony each 0.01% and scandium 0.0015%.

Sample No. 4 was from the dump to the west of the retreatment plant. This dump was also estimated to contain 12,000 tons. Elements measured were copper and lead 0.4%, zinc 0.2%, arsenic and tungsten each 0.02%, antimony 0.015% and scandium 0.002%.

Although these dumps contain more copper, lead and zinc than those at Canbelego, the concentrations are still too small to warrant further work at this time. If any large scale use of the sands for construction purposes were contemplated, it might be worth considering the installation of some low cost form of gravity concentrator (such as spirals or pinched sluice concentrators) as part of the materials handling system to remove a heavy mineral concentrate for further processing and at the same time clean up the sands.

Armidale Inspector's District

Gulf Creek near Cobbadah

There were no signs of treatment plant dumps at the mine or smelter sites, but there were some dumps of ore, possibly remnants of a heap roasting process, and evidence of construction of vats apparently in connection with the recovery of copper from mine water.

The smelter site is reached by turning up the hill at a large tree adjacent to the Gulf Creek sign facing toward Cobbadah on the main road through the village. The mine site is further up the valley and was joined to the smelter site by a road and tramway in past years. The tramway has fallen into disrepair, and the road is badly washed out in places.

Dumps at the smelter site were estimated to contain a total of 6,000 tons of slag.

Conrad Mine, Howell.

The mine is reached by a turnoff to the left from the Tingha-Copeton road at Howell, which is 5.6 miles from the main Bundarra-Inverell road. The tailings dumps are downstream from the mine site and 1.7 miles from the turn off at Howell.

Samples Nos. 1 and 2 were taken from the upper and lower sections of the tailings dump which was estimated to contain a total of 21,000 tons. Elements measured in Sample No. 1 were arsenic 0.6%, lead 0.3%, tin 0.25%, rubidium 0.04%, lithium 0.025%, silver 0.003%, and in Sample No. 2, lead 0.6%, arsenic 0.5%, tin 0.25%, rubidium 0.025% and silver 0.0025%.

The slag dump situated to the north of the upstream end of the tailings dump was estimated to contain 6,500 tons.

The tin content of the tailings dump material seemed high enough to warrant mineragraphic examination to show in what way the tin occurs. Results of a mineralogical examination of these samples are reported in Appendix II.

Edwards and Wade (1953) give a general description of this deposit as it was known before it was worked by Broken Hill South Ltd.

The tailings sands are particularly white and glistening in appearance, and may have some value for decorative purposes in building construction.

A flotation process for cassiterite was tried on tailings from this mine - see Evans, Ewers and Meadows, 1962. Rougher concentrates assaying 15-20% tin were made with a recovery of 85% of the tin present in the deslimed flotation feed. Approximately 25% of the tin in the tailings was lost in desliming the feed for flotation. The tin content of the sample used for this work was 0.5%.

Richards (1963) discusses the abundances of copper, lead, zinc and silver in this discordant hydrothermal orebody.

Webb's Consols Mine, Emmaville

The mine is located about half a mile east of the Inverell-Emmaville road. The turn off is less than half a mile from the junction of this road with the road to Glen Innes via Wellingrove, and between this road junction and the Severn River.

Mr. N. Dawson of Emmaville advised that the tailings dumps at this mine represented only nine months work. Much larger quantities of tailings resulting from 5 years work had been washed away by a flood.

Sample No. 1 was from an auger hole in the small slime dump adjacent to the treatment plant. The dump was estimated to contain 300 tons, and elements measured were zinc 8% arsenic 4%, lead 3%, manganese 0.5%, rubidium 0.3%, copper 0.15%, lithium 0.05%, yttrium 0.02%, silver 0.005% and scandium 0.0012%.

Sample No. 2 was from the sand dump, further downstream and estimated to contain 2,000 tons. The elements measured in this auger hole sample were: zinc 15%, arsenic 7%, lead 2%, manganese and rubidium each 0.3%, copper 0.2%, lithium 0.05%, yttrium 0.02%, cadmium 0.015%, cesium 0.01% and silver 0.0025%.

No further research work is warranted because of the small quantity of tailings available. Tate (1962) records the results of a geophysical survey of this area made in 1953.

Ottery Mine, Tent Hill

The mine is situated about ¼ mile to the west of the Tent Hill - Torrington road. The turn off is just over two miles from the Emmaville - Tent Hill - Deepwater road and just short of a grid and gate when travelling from Tent Hill.

The first three samples were taken from auger holes in a tailings dam in a gully below the mine, estimated to contain 4,500 tons.

Sample No. 1 was from the south west corner of the dam and composed mostly of yellow sand. Elements measured were tin 2%, arsenic 1% rubidium 0.08%, lithium 0.02% and scandium 0.0015%.

Sample No. 2 was from reddish coloured sand and slime from the area near the wall of the dam. Elements measured were arsenic 2.0%, lead 0.5%, tin 0.3%, rubidium 0.12%, cesium 0.015%, silver and scandium both 0.002%.

Sample No. 3 was taken from grey sand in the centre of the dam. Elements measured were arsenic 1.0%, tin 0.6% and rubidium 0.07%.

Other samples were from a dump estimated to contain 1,500 tons and composed of grey-green, cream, white and red sands and slimes - probably residues from the furnace plant, as the dump was close to the furnace plant ruins.

Sample No. 4 was composed of light coloured material from walls of a gully cut through the dump. Elements measured were arsenic 6%, tin 1.2%, antimony 0.01% and rubidium 0.05%.

Sample No. 5 was of reddish coloured material from the same location. There appeared to be rather more reddish material than light coloured material in the dump. Elements measured were tin 1%, arsenic 0.8%, lead 0.3%, rubidium 0.1% and scandium 0.0015%.

There was also a dump, probably of hand picking rejects, above the dump of furnace residues. This dump was not measured or sampled. There were some signs of recent activity in picking over the dump.

The tin content of the dump material suggests that some additional mineralogical work to discover the mode of occurrence of the tin in this material would be worth while, and obtain some indication as to whether it can be recovered economically. Results of mineralogical examination of the samples are reported in Appendix II.

The C.S.I.R.O. - Melbourne University Ore Dressing Laboratory have undertaken research work on ore and tailings from this mine on three occasions. Hart (1939) refers to treatment of a pyritic tin ore for recovery of tin values in a marketable concentrate. Flotation of sulphides followed by gravity concentration of cassiterite was suggested. Hart (1945) refers to treatment of sands (said to total 60,000 tons) containing 0.9% Sn. Further grinding and gravity concentration did not seem likely to give satisfactory results. Flotation of cassiterite was suggested as a possible solution. Blaskett (1950) refers to recovery of tin from residues from roasting arsenical ore from this mine.

Webb's (Collison's) Silver Mine, Emmaville

The mine is reached by a signposted turn off from the Emmaville - Argenton road, 1.8 miles from Emmaville. There is also a signpost in Emmaville indicating the road to follow from the town. The distance from Emmaville to the mine is approximately nine miles.

Three samples were taken from jig tailings dumps estimated to contain 10,500 tons. These are remnants (1/5th only according to Mr. N. Dawson) of a much larger tonnage which has been swept away by floods.

Sample No. 1 was from the northerly portion of the main dump which was estimated to contain 10,000 tons. Elements measured were : zinc 2.5%, copper 0.8%, arsenic 0.7%, rubidium 0.5%, manganese 0.3%, antimony 0.25%, tin 0.15%, lead 0.1%, lithium 0.06%, cesium 0.04%, yttrium and cadmium 0.015%.

Sample No. 2 was from the north west portion of the same dump and elements measured were zinc 3%, arsenic 2%, copper 0.9%, antimony 0.4%, rubidium 0.25%, manganese 0.2%, lead 0.1%, lithium 0.06%, silver 0.04% (13 ozs per ton), cesium, scandium and yttrium each 0.015%.

Sample No. 3 was from a separate dump to the south (roughly estimated to be of the order of 500 tons) which had apparently extended much further into the gully at one time. Elements measured were zinc 4% arsenic 1.5%, copper and antimony each 1%, lead 0.8%, manganese 0.4%, tin 0.25%, rubidium 0.2%, lithium 0.06%, silver 0.04% (13 ozs per ton), cadmium 0.025%, scandium and cesium each 0.015%, yttrium 0.002%.

Sample No. 4 was from sands in the tailings dam near the present treatment plant. In this dam and in the creek below it is estimated that there were from 2-500 tons of material. Elements measured were arsenic 5%, zinc 3%, copper 1%, lead 0.5%, manganese 0.5%, rubidium and antimony each 0.3%, barium 0.25%, lithium 0.06%, cesium and silver 0.03% (10 ozs per ton) and yttrium 0.015%.

Reports by Henkel (1960a and 1960b) refer to examination of the problem of dump retreatment. Recoveries by flotation in marketable grade concentrates were poor. Analysis of tailings from the 1962 treatment plant (sample No. 4) showed that it was no more effective than earlier ones. Silver is present in the tailings at the level of about 10 ozs per ton and some mineragraphic work on the occurrence of zinc and silver values is reported in Appendix II.

Curnow's Mine, Torrington

The dumps in this mine are in two locations, adjacent to the main shaft and some distance downhill on the banks of Lottery Creek. The mine may be reached by turning off to the right from the Torrington-Emmaville road 1 to 2 miles out of town. Sands from the Dutchman mine nearer Torrington have been retreated at Curnow's and these sands, together with those from retreatment of Curnow's original dumps, now repose on the banks of Lottery Creek.

Sample No. 1 was from the largest of the dumps on Lottery Creek, which total approximately 2,500 tons in all. Elements measured were tin 0.25%, rubidium 0.1%, lithium 0.05%, yttrium 0.015% and scandium 0.0015%.

Sample No. 2 from a smaller dump contained tin 0.15%, rubidium 0.15%, lithium 0.04%, cesium 0.015%, scandium 0.0012%.

Sample No. 3 was from the sand dump at the mine which was estimated to contain 500 tons. Elements measured were tin 0.5%, rubidium 0.18%, lithium 0.05%, yttrium 0.015% and scandium 0.002%.

Sample No. 4 was taken from slime dumps at the mine which were estimated to contain a total of 1,000 tons. Elements measured were tin 2.0%, rubidium 0.2%, lithium 0.05%, yttrium 0.03%, cesium 0.015% and scandium 0.007%.

The grades and tonnages of material available are not sufficient to warrant further work.

Mulholland (1953) gives a general description of this and other mines in the district.

Fielder's Hill Mine, Torrington

The mine is situated in heavily timbered country to the west of the Silent Grove road, a few miles north west of Torrington. Mr. A.W. Martin of Torrington was kind enough to act as guide in the Torrington area : without his assistance the sampling of dumps in the area would have been much less complete and more time consuming.

The sample was taken from the remains of the original Fielder's Hill dump. A large quantity of retreated material was dumped further downstream, but this was not sampled. The remnants of the original dump were estimated at 4,000 tons, and the retreated material was estimated at 4,500 tons. Elements measured in the sample were tungsten 0.1%, lithium and bismuth each 0.04% yttrium 0.03% rubidium 0.01% and scandium 0.0012%.

No further work is warranted on the basis of this analysis.

Bismuth Mine, Torrington

As in the case of Fielder's Hill there were two sets of dumps at the Bismuth mine, one the remnants of the original dump and the other the tailings from retreatment of the original dump.

Sample No. 1 was taken from the remnants of the original dump near the mine. These were estimated to total 2,400 tons. Elements measured in the sample were bismuth 0.08%, tungsten 0.05%, lithium 0.04%, beryllium 0.03%, rubidium 0.025%, yttrium 0.02% and scandium 0.0015%.

Sample No. 2 was from the dump of retreated tailings by the creek below the Bismuth Mine dam. The dump was estimated to contain 3,000 tons. Elements measured were tungsten 0.25%, bismuth 0.06%, yttrium 0.04%, beryllium and lithium each 0.02%, rubidium 0.015% and scandium 0.002%.

Additional work is not considered to be warranted on these dumps.

Blaskett (1947) refers to work done on concentrates from retreatment of the Fielder's Hill and Bismuth Mine dumps by Continental Leases Pty. Ltd.

It is interesting to note that the retreated tailings are richer than the remains of the original dump. This suggests that the material for retreatment was selected from the richer parts of the original dump.

Lismore Inspector's District

Cangai

The smelter site is clearly visible from the road which runs along the east side of the Nymboida River. The mine is approximately 2 miles up a gully to the north and is accessible by a well defined track intersected by some boggy patches.

No samples were taken as there are no treatment plant dumps. However, the slag dump was estimated to contain 10-15,000 tons, although the accuracy of this estimate is lower than usual because of the very obscure nature of the shape of the ground surface beneath the dump.

E.R. & S. Mill, Drake

The mill foundations and dumps are adjacent to and visible from the Cheviot Hills road, half a mile from the township and on the right hand side. The mill was erected with the object of operating on a custom basis for small producers, but supplies of ore did not come forward in sufficient quantity, metallurgical efficiency was low and the mill closed in 1953 after several years of intermittent and unprofitable operation.

The two dumps are located in a gully, and though both contain sands and slimes the downstream dump is principally slimes. This dump is estimated to contain 2,500 tons, the other 500 tons.

Sample No. 1 was taken from the sandy portions of both dumps. Elements measured were lead 0.2%, copper 0.12%, zinc 0.1%, rubidium 0.015% and scandium 0.002%.

Sample No. 2 was from slimes in the downstream dump, and elements measured were lead 0.8%, copper 0.7%, zinc 0.3%, rubidium 0.04%, scandium 0.004%.

Further work on these dumps is not recommended. See Lawrence (1962) for a description of the area and mineragraphic examination of ore samples from surrounding mines.

Wagga Wagga Inspector's District

West Wyalong

Dumps sampled in this area were selected after discussions with the engineering staff of the local Council. The dumps selected were within the town area and known as the Perserverance St. dumps.

They are visible to the right of the Mid-Western Highway entering the town from the direction of Wyalong, and are situated between this road and a drainage channel.

Sample No. 1 was taken from the higher of the two dumps which was estimated to contain 4,500 tons. Elements measured were lead 0.18%, zinc 0.15%, rubidium 0.12% and scandium 0.008%.

Sample No. 2 was from the lower dump further east which was estimated to contain 6,000 tons. Elements measured were manganese 0.25%, lead 0.1% arsenic 0.05%, rubidium 0.04%, and scandium 0.006%.

The dumps do not contain elements of value in economically significant quantities, and continuation of the present practice of using them as a source of filling would appear to be appropriate.

Milburn Creek Mine, Mt. McDonald

The mine is situated to the left of the road from Woodstock to Wyangala Dam about 12½ miles from Woodstock and about ¼ to ½ mile short of a turn off to Mt. McDonald lookout. The workings are about 100 yds. from the road, but not readily visible from it, being over the crest of the hill. Although there were old foundations suggesting that a treatment plant existed at one time, there are no signs of tailings dumps, apart from a small silted up dam. Traces along the creek bed suggest that tailings may have been washed away by heavy rain in past years.

Sample No. 1 was taken from slime found in the treatment plant ruins. Elements measured were rubidium 0.015% and scandium 0.003%.

Sample No. 2 was from sands in the same location. Elements measured were copper 0.1%, rubidium 0.015% and scadium 0.001%.

The quantities of material represented by those samples were insignificant. There are many shafts, adits, potholes and costeans scattered over both sides of a spur running N.E. from the main road and there is evidence that leaching to recover copper has been attempted.

The partly filled dam in the creek near the old treatment plant may contain some slimes, but was not accessible for sampling. In any case the area did not contain sufficient material to warrant additional work.

Slag dumps are visible to the east of the Wyangla Dam road at a bridge over a creek about ¾ mile toward Woodstock from the mine. These dumps are small, and though not measured were estimated to contain 3-5000 tons of slag.

Frogmore Wolfram Mine (Phoenix : Mt. Charlested)

The mine is reached by turning to the right just beyond Frogmore from the Frogmore-Forest Creek road. The track passes a homestead visible from the main road, and leads on through two gates and past a dam to the mine. The left hand fork is taken at the first gate beyond the homestead, so that the left bank of the creek beyond is followed downstream. The mine is on the left side of the creek below the dam and beyond the next gate.

There are extensive mullock damps adjacent to the headframe, and below the treatment plant foundations, sand and slime dumps extend to the creek. Some of the dumps have been breached by rainwater, and sand is evidently scoured out when it rains heavily.

Sample No. 1 was taken from coarse material, probably jig tailings, from the upper dump. Elements measured were tungsten 0.4%, copper 0.3%, arsenic and rubidium each 0.15%, bismuth 0.05%, cesium 0.02%, scandium 0.0015% and silver 0.001%.

Sample No. 2 was taken from sands from the upper dump, which was estimated to contain 4,250 tons. Elements measured were tungsten 0.25%, bismuth 0.15%, rubidium 0.03%, and silver 0.001%.

Sample No. 3 was from sands from the adjacent but lower dump, estimated to contain 1,300 tons. Elements measured were tungsten 0.5%, arsenic 0.5%, rubidium and bismuth each 0.05% and silver and scandium each 0.001%.

Sample No. 4 was taken from the slime dam in the creek below the mine which also contains sands washed down from the dumps higher up the hill toward the treatment plant. The tonnage in the dam might be as much as 7,500 tons. Elements measured in the sample were tungsten 1%, bismuth 0.12%, rubidium 0.07%, lithium 0.02%, scandium 0.003% and silver 0.001%.

The upper dump shows signs that some tailings have been removed, either for retreatment or for constructional purposes.

Further work on the samples does not appear warranted because of the small size of the dumps. The highest grade of tungsten is in the slime dump from which good recovery on retreatment could be expected to be difficult.

Examination of work done by Hart (1939) shows grades of tailings dumps much higher than those obtained in this tailings survey. Apparently the dumps were retreated and the tailings remaining at the present time are, at least in part, from this operation. See the Annual Reports of the New South Wales Mines Department 1939-45 at page 29 for a reference to operations taking place in 1941-43. Blaskett (1953) refers to gravity concentration of an ore being mined at that time and treated by Tungsten Consolidated N.L. at Frogmore. This operation probably refers to this same mine, and the upper tailings dumps may well belong to this phase of the mine's history.

Frogmore Copper Mine

The mine workings lie on both sides of the main road from Boorowa, just south of the town. There are some scattered tailings dumps, totalling perhaps 200 tons on the section on the eastern (upper) side of the road. Elements measured in a composite sample from this material were copper 1%, rubidium 0.01% and silver and scandium each 0.005%.

A small slag dump, estimated to contain 3,000 tons, was also present on the hillside below the tailings remnants. Some attempt at sampling had apparently been made as pits had been excavated in portions of the dump.

No further work is warranted by the results of analysis of the samples from this mine.

Kangiara

Mine workings and dumps at Kangiara are situated about 200 yards from the western side of the main road which runs from Boorowa to the Hume Highway near Yass. Kangiara is midway between these two centres, and though the workings are screened by trees from the road, they can be reached through a clearing at the south end near the Kangiara village signpost.

Sample No. 1 was from the southernmost dump estimated to contain 2,600 tons. Elements measured were lead 8%, zinc 7%, copper 2%, barium 0.4%, rubidium 0.15%, antimony and silver each 0.03% (10 ozs per ton), cadmium and yttrium each 0.015%, and scandium 0.004%.

Sample No. 2 was from dumps on the bank of the creek estimated to contain 1,200 tons. Elements measured were lead 2%, copper 0.7%, zinc and rubidium 0.2%, silver 0.015% and cesium 0.01%.

Sample No. 3 was from jig tailings forming the uphill section of the northernmost dump, which was estimated to contain a total of 1,000 tons of sands and jig tailings in equal proportions. Elements measured were lead 6%, zinc 2%, copper 0.9%, barium 0.25%, rubidium 0.2%, silver and lithium each 0.025%, antimony 0.02%, cadmium and yttrium 0.015% and scandium 0.004%.

Sample No. 4 was taken from the sandy section of the northernmost dump. Elements measured were lead 7%, zinc 4%, copper 1.2%, barium 0.2%, rubidium 0.15%, silver 0.04% (13 ozs per ton) antimony 0.03%, lithium 0.02%, cadmium 0.015%, yttrium 0.01% and scandium 0.004%.

Sample No. 5 was from the slime dump (estimated to contain 1,500 tons) situated between the other three groups of dumps. Elements measured were lead 20%, zinc 4%, copper 4%, barium 0.5%, rubidium 0.1%, antimony 0.05%, silver 0.035%, (11½ ozs. per ton) lithium 0.025%, cadmium 0.012% and scandium 0.006%.

There was also a small slag dump containing less than 200 tons which was not sampled.

Lead, zinc, copper and silver in quite high proportions are present in all tailings. Cadmium, cerium, indium and gallium are also present, but in much lesser amounts. Retreatment of such small dumps does not seem worth while at current metal prices, but the high values in the dumps suggests that major metallurgical problems were encountered, but not solved, by past operators. A mineralogical examination of coarse tailings is reported in Appendix II.

Samples Submitted by Companies

North Broken Hill Ltd.

Tailings dumps in the mine lease area were sampled by the company. Details of the samples forwarded are set out below :

Sample No. 1 - Dump Plant Residue was from a dump resulting from retreatment of slimes for recovery of lead and zinc concentrates. Details of this operation are given by Keats (1956). The quantity of material was estimated as being of the order of 100,000 tons. Elements measured in the sample were manganese 5%, zinc 4%, lead 3%, rubidium and barium each 0.1%, antimony 0.04%, lithium 0.03%, arsenic 0.02% and silver 0.005%.

Sample No. 2 - Old North Mill Residue was from tailing produced in excess of underground filling requirements prior to 1939. The quantity in the dump was estimated to be in excess of 1.5 million tons. Elements measured were manganese 7%, zinc 4%, lead 0.8%, rubidium 0.12%, barium 0.1%, tungsten 0.06%, lithium and arsenic each 0.025%, antimony 0.015% and silver 0.003%.

Sample No. 3 was from New North Mill Residue - No. 1 Dam, which consisted of fine material removed from flotation tailing before its being sent underground for mine filling. These slimes, estimated at 1.5 million tons, had accumulated since 1939. Elements measured were:

manganese 5%, zinc 3%, lead 0.8%, rubidium 0.1%, lithium 0.03% and silver 0.0025%.

Sample No. 4 was from New North Mill Residue - No. 2 Dam, which was of similar origin to No. 1 Dam and was estimated to contain 1.1 million tons. Elements measured in this sample were : manganese 5%, zinc 2.5%, lead 0.7% rubidium and barium each 0.12%, lithium 0.035%, arsenic 0.025%, silver 0.0015%.

Sample No. 5 was from De Bavay Tailings Dump, which is a remnant pile of tailings from the Amalgamated Zinc Company's plant which retreated leady tailings from local mining companies plants. Much of the original pile has been used for underground filling, but it was estimated that 600,000 tons remain. Elements measured include : manganese 5%, zinc 7% lead 3%, copper 0.1%, arsenic 0.07%, rubidium 0.05%, antimony 0.04% and silver 0.008%.

Sample No. 6 was from the De Bavay Slime Dump, which contained about 150,000 tons of fine material and was derived from the later operations of the Amalgamated Zinc Company. The elements measured in this sample were: manganese 3%, zinc 5%, lead 6%, copper and rubidium 0.1%, antimony 0.03%, arsenic 0.025%, lithium 0.02%, silver 0.012%.

Sample No. 7 was of current mill tailing and consisted of a bulk sample for the year ended 30th June 1962. At that time tailing was being produced at a rate of 230,000 - 250,000 tons per year, of which 60% was sent underground for stope filling, the remaining 40% being run into No. 2 Residue Dam. Elements measured in the sample were manganese 7%, zinc 2.2%, lead 0.8%, rubidium 0.12%, barium 0.09%, lithium and arsenic each 0.03%, silver 0.0025%.

The company advises that it has carried out research on the recovery of lead and zinc concentrates from the older dumps and that the Australian Mineral Development Laboratories have undertaken investigations into the possibility of recovering rhodonite, garnet and fluorite from current mill tailing. In 1950 the heavy mineral content of plant residue was investigated, and C.S.I.R.O. Mineragraphic Section Report No. 631 refers to examination of a specimen of heavy mineral concentrate prepared by the company.

These investigations cover the obvious lines of enquiry into possible value of the tailing dumps. The only other possibility which appears worthy of consideration at some future time is the leaching of the tailings for recovery of zinc, lead, silver and possibly manganese, values. Some strain of bacteria might be developed to assist such a process which would probably have to be carried out in situ.

In considering the economics of recovery of manganese from the tailings it should not be forgotten that large aggregations of manganese minerals such as rhodonite occur underground and it would be possible to mine these separately to the lead zinc ore. Such material would have a much higher manganese content than the tailings, and might present a more economical starting point for the recovery of manganese than the tailings.

Cobar Mines Pty. Ltd.

The samples from the Cobar area were supplied by this company, but the dumps sampled are the result of earlier activities of other companies, particularly New Occidental Gold Mines N.L.

Sample No. 1 was from the Chesney Mine slime dump, estimated to contain 40,000 tons. Elements measured in this sample were copper 0.3% and rubidium 0.15%.

Sample No. 2 was from the south east slime dump at the Occidental mine, estimated to contain 300,000 tons. The following elements were measured: copper 0.12%, bismuth 0.03%, tungsten 0.02% and rubidium 0.012%.

Sample No. 3 was taken from the pink dump at the New Cobar Mine, estimated to contain 2,000 tons. The following elements were measured: lead 0.3%, arsenic and copper, each 0.1%, bismuth 0.04% and tungsten 0.03%.

Sample No. 4 was from the south west slime dump at the Occidental mine, estimated at 1.5 million tons, and the following elements were determined in this sample: copper 0.15%, bismuth 0.04%, tungsten 0.03%.

Sample No. 5 was from the Occidental Mine, south slime dump, estimated to contain 120,000 tons. Elements measured were copper 0.2%, bismuth 0.04% and tungsten 0.02%.

Some form of in situ leaching would seem the only process likely to be cheap enough to recover values from these dumps in the future. Some work on bacterial action has been carried out in the U.S.A. and there are references in the technical literature to this.

Aberfoyle Tin N.L. - Ardlethan

The geologist in charge of this company's exploration programme in the area (Dr. G. Westner) took samples and estimated tonnages for the following dumps:

White Crystal (sample No. 1) - estimated tonnage 21,700. Elements measured: boron 1.5%, arsenic 0.8%, tin and lead, each 0.6%, copper and tungsten each 0.1%, lithium and rubidium each 0.09%, bismuth 0.02%, silver 0.0012%.

Carpathia (sample No. 2) - estimated tonnage 24,700; elements measured being boron 3%, arsenic, lead and tin each 1%, copper 0.12%, rubidium 0.1%, tungsten 0.08%, bismuth 0.05%, lithium 0.045%, antimony 0.02%, silver 0.004%.

Wild Cherry (sample No. 3) - estimated tonnage 36,800; elements measured being boron 0.8%, arsenic 0.7%, tin 0.5%, lead 0.25%, tungsten 0.06%, lithium 0.04%, bismuth 0.03%, silver 0.001%.

The Southern Cross, containing 10,600 tons was the smallest dump, and the sample (No. 4) contained the following measured elements; boron 1%, arsenic 0.7%, tin 0.3%, lead 0.25%, rubidium 0.05%, tungsten 0.025%.

The values in tin are such as to suggest that it may well be profitable to run all this material through the treatment plant of the open cut tin mine operated by Ardlethan Tin N.L., in which the head grade of ore is expected in the range 0.3-0.4% Sn.

A description of the early mining operations which produced the tailings dumps mentioned above is set out in Garrety (1953).

The Zinc Corporation Ltd. & New Broken Hill Consolidated Ltd.

Tailings from both Z.C. and N.B.H.C. mills are sent to a residue plant where they are combined and classified. The coarser fraction is sent underground while the finer fraction is stacked on the surface. The proportion sent underground is varied by adjustment of the classifiers to meet underground fill requirements.

Composite samples taken over a period of four weeks ending 22nd February 1963 were submitted by the company. The following elements were measured:

Sample No. 1 - Residue Plant Feed - manganese 20%, zinc 4%, lead 0.7%, rubidium 0.07%, tungsten 0.03%, and silver 0.0015%.

Sample No. 2 - Residue Plant Sands (fill) - manganese 10%, zinc 3%, lead 0.6%, rubidium 0.035%, tungsten 0.02%, silver 0.0012%.

Sample No. 3 - Residue Plant Slimes (stack) - manganese 10%, zinc 5%, lead 0.7%, rubidium 0.08%, tungsten 0.03%, cadmium 0.02%, lithium 0.012%, silver 0.0018%.

The main point noted in these three analyses is the discrepancy in manganese assays - the individual fractions showing only half the manganese content of the feed to the plant. As the assay for the individual fractions is closer to the North Mine values of 5-7% it seems likely that the value of 20% Mn is abnormal.

The company also provided results of a spectrographic analysis of a gravity concentrate made from mill tailing in 1953 when the recovery of scheelite was being investigated. These and results of other tests on higher grade portions of old mill tailings sampled in 1946-47 are set out in Appendix III.

Lake George Mines, Captains Flat

This mine ceased production in March 1962. At that time retreatment of tailings in the plant to produce a low grade pyritic concentrate was investigated, but abandoned because of economic difficulties. There are a total of approximately 2,150,000 tons of tailings in dumps at Captain's Flat as follows:

Area	Tonnage	Assay - %		
		Pb	Zn	Fe
Keating's	300,000	1.2	3.3	20.8
Mine Dams	1,000,000	0.9	1.5	17.8
Mine Stockpile	850,000	0.85	1.5	17.0

A spot sample from the Keating's area dump was submitted for analysis. Elements measured were zinc 8%, lead 1.2%, arsenic 0.2%, copper 0.3%, rubidium 0.035%, barium 0.02% and silver 0.001%. The other metallic elements, likely to be of interest are present at the faint trace (0.001-0.01%) level only and do not appear interesting at such low concentrations. The mine geology is discussed in Lake George Mines Geological Staff (1953).

RESULTS BY ELEMENTS

While the above description of individual samples sets out the main elements which occur in the analyses, it is of interest to consider the occurrence of some of the rarer elements throughout the dumps sampled.

Gallium

Analyses showed gallium in the faint trace range (0.001% to 0.01%) in samples from Webb's Consols Mine (No. 1) Curnow's Mine (No. 4) and Kangiara (Nos. 1,2,3, and 5). Concentrations in the next lower range (0.001 to 0.0001%) were obtained in samples from Burraga (Nos. 1,2 and 3), London Mine, Parkes, Peak Hill (No. 2), Mt. Hope (No. 5), Shuttleton (No. 3), Canbelego (Nos. 1 and 5), Girilambone (No. 4), Webb's Silver Mine (Nos. 1-4), Drake (No. 2) and West Wyalong (No. 2).

Indium

The highest concentrations were in the range 0.01% to 0.001% and were found in samples from Burraga (Nos. 2 and 4), Webb's Consols, Emmaville (Nos. 1 and 2) and Kangiara (Nos. 1,4 and 5). Lesser concentrations, in the range 0.001% to 0.0001% were found in samples from Overflow Mine, Bobadah (Nos. 2 and 3), Nymagee, and Webb's Silver Mine (No. 3).

Germanium

The highest concentration, in the range 0.01% to 0.001% was from the Bsimuth Mine, Torrington (No. 2). Lesser concentrations in the range 0.001 to 0.0001% were obtained in analysis of samples from Mineral Hill (Nos. 1 and 2), Nymagee, Bodangora (No. 1), Ottery Mine, Tent Hill (No. 1), Fielders Hill, Torrington, North Broken Hill (Nos. 2, 3, 4, 5, 6, 7), Ardlethan (Nos. 1 & 2) and Cobar (all samples).

Scandium

This element was present in minor quantities in most samples. Those in the highest range of concentration (0.1% to 0.01%) were : London Mine at Parkes, Peak Hill (No. 1) and Webb's Silver Mine (Nos. 1, 2 and 3).

Silver

A number of samples showed concentrations in the range 0.1% to 0.01%, corresponding to 32.6 to 3.26 ozs per ton. These samples were: Kangiara (Nos. 1-5), Webb's Silver Mine (Nos. 1-4), Overflow Mine at Bobadah (No. 3), Mineral Hill (Nos. 1 and 2) and North Broken Hill (No. 6).

Selenium

As would be expected, highest concentrations of selenium were present in samples from copper mine dumps. Tin, gold and lead-zinc dumps showed low values in selenium. It is interesting to note that the dumps with the highest sulphur contents (Kangiara, Webb's Consols and Junction Reefs) show the highest sulphur-selenium ratios. For a discussion of the selenium contents of some sulphide minerals from Australian mineral deposits see Edwards and Carlos (1954).

Beryllium

Highest values in beryllium were found in tailings from the Bismuth Mine at Torrington, but these were only 0.03% and 0.02% in samples 1 and 2 respectively. Curnow's Mine (No. 1) and the sample from Fielder's Hill both gave results in the range 0.01-0.001%. Samples giving results in the very faint trace range (0.001 to 0.0001%) were obtained from Ardlethan (Nos. 1, 2 and 3), Webb's (Collison's) Silver Mine (No. 1), the Conrad Mine at Howell (No. 2), the Ottery Mine at Tent Hill (Nos. 1 and 4), Nymagee, Shuttleton (No. 1) and Canbelego (Nos. 1, 3 and 5).

CONCLUSIONS & RECOMMENDATIONS

The main conclusion reached from the survey was that of the dumps examined, there were none which could be said to justify further work by the Bureau, either by way of careful sampling; or by way of research work to develop methods of recovering valuable minerals. In most cases the small size of the dumps alone is sufficient to exclude them from further consideration. In others where larger quantities of material are available, there is either a lack of minerals in sufficient quantities, or alternatively, the minerals or elements present in the tailings can be more economically produced by conventional processes from the crude ore, or from other sources in Australia and overseas.

The following dumps seem to offer some potential for future exploitation:

At Burraga some leach in situ process might give an economical return when applied to the dump which contains a considerable quantity of copper. Even a low percentage recovery might be profitable to a small syndicate.

Some of the older Broken Hill dumps such as are represented by samples 5 and 6 from North Mine contain significant quantities of lead, zinc and silver, and though recovery of values in this material may not be economically possible at the present time, the use of these dumps for underground fill should be restricted, unless their particular situation is such that they create a dust nuisance. At some future time it may be possible to recover the values in these dumps. Perhaps some form of preconcentration using spirals or pinched sluice concentrators as in the beach sands industry could help improve the economics of retreatment.

At Ardlethan, the retreatment of all dumps conjunction with the open cut tin mine of Ardlethan Tin N.L. seems well worth examination by the company. Tin values in the tailings appear higher than the expected head grade of ore from the open cuts.

Other dumps, such as those at Peak Hill, West Wyalong, Bodangora and Girilambone are being used as sources of fill and constructional materials at present, and future use of these and other dumps for this purpose seems logical. The particularly white and glistening appearance of the sands at the Conrad Mine suggests that these might warrant consideration for some decorative purpose in construction. At a number of locations copper slag dumps were observed and these might provide aggregate for construction purposes though provision for crushing would have to be made in each case.

At Shuttleton, one of the dumps of oxidised copper tailings appears to be high enough in grade to use for trace element fertilizer production, were it located in Western Australia. However, because of the circumstances prevailing in New South Wales it is doubtful if it could be used for this purpose economically in this State.

The survey does not appear to have revealed any unexpected concentration of the more unusual elements and certainly none of these are present in economic quantities.

ACKNOWLEDGEMENTS

The assistance of Inspectors of Mines and of leaseholders in the various mining fields in selection and location of dumps for sampling is gratefully acknowledged. The action of the larger mining companies in making available samples and background information on their tailings dumps is also much appreciated.

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APPENDIX I

SPECTROGRAPHIC ANALYSES

Detection-Limit Concentrations of Elements

D.C. Arc Excitation

ELEMENT	Per cent	p.p.m.	ELEMENT	Per cent	p.p.m.
Ag	0.00005	0.5	Na	0.00005	0.5
Al	0.0002	2	Nb	0.003	30
As	0.01	100	Nd	0.001	10
Au	0.001	10	Ni	0.0002	2
B	0.001	10	Os	0.005	50
Ba	0.0002	2	P	0.05	500
Be	0.0005	5	Pb	0.0002	2
Bi	0.0005	5	Pd	0.001	10
Ca	0.0002	2	Pr	0.001	10
Cd	0.001	10	Pt	0.01	100
Ce	0.04	400	Rb	0.01	100
Co	0.0002	2	Re	0.01	100
Cr	0.0003	3	Rh	0.001	10
Cs	0.1	1000	Ru	0.001	10
Cu	0.00005	0.5	Sb	0.003	30
Dy	0.001	10	Sc	0.0002	2
Er	0.001	10	Si	0.002	20
Eu	0.001	10	Sm	0.05	500
Fe	0.0005	5	Sn	0.001	10
Ga	0.0003	3	Sr	0.0001	1
Gd	0.02	200	Ta	0.01	100
Ge	0.0005	5	Tb	0.001	10
Hf	0.01	100	Te	0.02	200
Hg	0.01	100	Th	0.01	100
Ho	0.001	10	Ti	0.001	10
In	0.0001	1	Tl	0.005	50
Ir	0.005	50	Tm	0.001	10
K	0.0002	2	U	0.05	500
La	0.001	10	V	0.0005	5
Li	0.01	100	W	0.005	50
Lu	0.001	10	Y	0.001	10
Mg	0.0002	2	Yb	0.001	10
Mn	0.001	10	Zn	0.0025	25
Mo	0.0005	5	Zr	0.002	20

APPENDIX II

Report No. MP2051-62 by A.M.D.L. on minerals in which the elements of interest were present in samples from the Conrad Mine at Howell, the Ottery Mine at Tent Hill, Webb's (Collison's) Silver Mine and Kangiara is set out below in full.

REPORT MP2051-62

YOUR REFERENCE:	Order Number 22298, 1962/224 dated 26.11.62.
MATERIAL:	Samples from tailings dumps (10)
LOCALITY:	See below
IDENTIFICATION:	See below
DATE RECEIVED:	17.12.62.
WORK REQUIRED:	Mineralogical examination

Investigation and Report by: P.J. Sweeney

Officer-in-Charge, Mineralogy Section: H.W. Fandor.

MINERALOGY OF MATERIAL FROM FOUR TAILINGS DUMPS

The samples were crushed to -52 mesh B.S.S. and heavy minerals were separated using bromoform (S.G. = 2.85). As a satisfactory separation was not obtained the material was super-panned and the resultant concentrates briquetted and examined in reflected light. The results are given below with the minerals listed in their approximate order of abundance.

CONRAD MINE, HOWELL: 1: PS7472

Tin is present as cassiterite and stannite

Galena	major
Arsenopyrite	minor
Cassiterite	minor
Sphalerite	minor
Stannite	minor
Chalcopyrite	minor

CONRAD MINE, HOWELL: 2: PS7473

Tin is again present as cassiterite and stannite

Galena	major
Chalcopyrite	minor
Arsenopyrite	minor
Cassiterite	minor
Stannite	minor
Covellite	trace

OTTERY MINE, TENT HILL: 1: PS7465

Tin occurs as cassiterite

Cassiterite	major
Arsenopyrite	minor
Chalcopyrite	minor
Hematite	minor
Pyrrhotite	minor

OTTERY MINE, TENT HILL: 2: PS7466

Hematite	major
Arsenopyrite	minor
Chalcopyrite	minor
Magnetite	trace
Cassiterite	trace

OTTERY MINE, TENT HILL: 3: PS7467

Hematite	major
Chalcopyrite	minor
Cassiterite	minor
Magnetite	minor
Arsenopyrite	minor

OTTERY MINE, TENT HILL: 4: PS7468

Arsenopyrite	major
Cassiterite	minor

OTTERY MINE, TENT HILL: 5: PS7469

Hematite	major
Arsenopyrite	minor
Cassiterite	minor

WEBB'S (COLLISON'S) SILVER MINE: 2: PS7470

No trace of silver was found; the silver minerals are probably so finely disseminated as to be undetectable.

Arsenopyrite	major
Sphalerite	major
Chalcopyrite	minor
Galena	minor
Tetrahedrite	minor
Stannite	minor - trace
Covellite	trace

WEBB'S (COLLISON'S) SILVER MINE: 4: PS7471

Arsenopyrite	major
Sphalerite	major
Tetrahedrite	minor
Chalcopyrite	minor
Galena	minor
Stannite	minor
Covellite	trace

KANGIARA: 3: PS7474

No silver minerals were observed.

Galena	major
Arsenopyrite	minor
Chalcopyrite	minor
Pyrite	trace
Covellite	trace

APPENDIX III.

Tailings Information from Zinc Corporation Ltd. Broken Hill N.S.W.

The tailings stacked on the leases of the Zinc Corporation Ltd., and New Broken Hill Consolidated Ltd. may be broadly divided into two classes, those resulting from the retreatment of material which had been stacked before the flotation process was introduced and those resulting from the treatment of crude ore after the introduction of the flotation process. The metal content of the first of these classes is considerably higher than that of the second.

A survey made in October 1962 gave an estimated quantity of 9.1 million tons of tailings stacked on the leases.

The older, higher grade portions of these tailings were sampled in 1946-47 with the following results:

Description	Tonnage	Lead - per cent.		Silver- ozs/ton	Zinc-per cent	
		Total	Oxidized		Total	Oxidized
High Grade Slimes	228,000	9.5	7.4	6.2	5.4	1.2
Sands	1,530,000	3.6	1.8	1.7	3.0	0.6
Low Grade Slimes	487,000	0.7	0.3	0.3	2.4	0.3

The remainder of the tailings consist of the fines from the treatment of crude ore and are of lower metal content than the above materials.

The total production of tailing by the Zinc Corporation Ltd. and New Broken Hill Consolidated Ltd. mills from August 1939 to the end of 1962 amount to 13,730,000 tons, with an average grade of 0.36% Pb, 0.18 ozs/ton Ag and 0.72% Zn. These tailings have provided sand for underground fill; the fine fraction has been stacked. The following figures are relative to the four weeks ending on 22nd February 1963.

Total feed to both mills-127,800 tons.

Total tailings from both mills-80,779 tons.

Estimated quantity of sand for fill-58,160 tons.

Estimated quantity of fines to stack-22,619 tons.

Size Analysis:

BSS Mesh	Percentage by Weight		
	Total Tailing	Underground Fill	Fines Stacked
+52	13.2	16.6	0.7
52-72	12.4	16.8	1.1
72-100	14.9	20.2	2.2
100-150	16.1	20.0	5.5
150-240	13.3	14.7	11.6
-240	30.1	11.7	78.9

Chemical Analysis:

Item Sought	Percentage		
	Total Tailing	Underground Fill	Fines Stacked
Lead (total)	0.48	0.43	0.65
" (oxidized)	0.09	0.04	0.23
Zinc (total)	0.85	0.57	2.25
" (oxidized)	0.05	0.02	0.12
Sulphur	0.85	0.67	1.92
Copper	0.024	0.017	0.041
Arsenic	0.030	0.021	0.055
Antimony	0.005	0.003	0.0078
Iron	4.5	4.38	5.2
Manganese	6.05	5.90	5.80
Alumina	2.93	2.45	3.68
Calcium Oxide	14.45	14.27	15.88
Magnesium Oxide	0.56	0.41	0.66
Fluorine	1.31	1.24	1.45
Carbon Dioxide	4.93	4.41	6.54
Phosphorus Pentoxide	0.48	0.48	0.52
Acid Insoluble	58.18	61.43	50.0
Silver (ozs per ton)	0.23	0.21	0.23

Results of spectrographic examination of a gravity concentrate made from the mill tailing in 1953 are set out below. This analysis was undertaken when the possibility of recovering scheelite from the tailing was being examined.

Major elements: Fe, Si.

Present in significant amount: Al, Mn, As, Pb, Ca, Na, Sb, Mg, Cu, Va, W, Ti, Zn.

Trace only: In, Mb, Sn, Ni, Ta, Ag, Ir.

Faint trace only: Pt, Pd.

Very faint trace only: Bi, Co.

APPENDIX IV

SURVEY OF MINERAL RESOURCES IN TAILINGS - DETAILED RESULTS - N.S.W.

Sample Location and Mark	Qualitative Analysis by Emission Spectroscopy - %						Semi-Quantitative Analysis by Emission Spectroscopy %	Chem. Analysis		Radio activity	Tonnage Est. in Dump	Date Sampled
	Major 100-10	Minor 10-1	Heavy Trace 1-0.1	Trace 0.1-0.01	Faint Trace 100-10 p.p.m. 0.01-0.001	Very Faint Trace 10-1 p.p.m. 0.001-0.0001		S %	Se p.p.m.			
Burraga 1		Cu	Zn Mn	Pb V Li Rb Ba Sr	Ni Sc Co Y Ag La Bi Sb Cr Zr Sn	Mo Ga	Cu 2.5, Zn 0.15, Mn 0.1, Sc 0.009, Rb 0.02, Li 0.02, Ag 0.001	0.88	*1		40,000	3/5/62
2		Cu	Zn Mn Ba	Pb Ni Co V Li Rb Sr	Bi Mo Y Sb La Cr Zr Sn In Sc	Ag Cd Ga	Cu 2.0, Zn 0.25, Mn 0.1, Rb 0.03, Sc 0.007, Ba 0.15	0.79	*1		40,000	3/5/62
3		Cu	Zn	Pb Li Mn Rb Ba Sr.	Ni Sc Co La Bi V Mo Sb Cr Sn	Ag Zr In Ga Y	Cu 2.0, Zn 0.1, Rb 0.035, Li 0.02, Sc 0.008	1.63	40		40,000	3/5/62
4		Cu	Mn Zn Ba	Pb Ni Rb Co La Bi As Sb Sn Sr Li	Ag V Mo Cr Cd In Sc Y	Zr	Cu 2.5, Zn 0.4, Mn 0.15, Ba 0.25, Rb 0.04, Ag 0.001 Sc 0.004.	0.45	4		40,000	3/5/62
Junction Reefs 1			Mn As	Cu Co Zn Rb Ba Sr La Ce	Pb Ni V Mo Y Cr Sn Nd Li Sc	Bi Zr	As 0.4, Mn 0.4, Rb 0.03, Sc 0.0012	4.93	*1	None Detected at Limit Equivalent to 0.002% U_3O_8	5,000	4/5/62
2			Mn As	Cu Co Zn Rb Ba La	Pb Ni V Mo Cr Sn Li Sr	Bi Zr Sc Y	As 0.9, Mn 0.25, Rb 0.04.	4.18	2		5,000	4/5/62
3			As Mn	Cu Co Zn Rb Ba Sr La Ce	Pb Ni V Mo Cr Li Sc Nd	Bi Zr Y	As 0.6, Mn 0.2, Rb 0.04, Sc 0.0015	5.92	2		5,000	4/5/62
4		As		Cu Zn Mn Li Rb Ba Sr	Pb Ni Co V Mo Cr Sc La	Zr Y	As 1.2, Rb 0.03, Sc 0.002	3.04	5		10,000	4/5/62
5		As		Cu Zn Mn Li Rb Ba	Pb Sc Ni La Co Bi V Mo Cr Sr	Zr Y	As 2.0, Rb 0.03, Sc 0.002	2.42	3		10,000	4/5/62
London Mine Parkes 1			Mn Rb Ba	Cu Sc Pb Nd Ni La V Y Zn Ce Cr Li Sr	Co Mo Zr	Ag Ga	Mn 0.4, Rb 0.15, Ba 0.2, Sc 0.02, Li 0.04, Y 0.01.	0.11	*1		6,000	5/5/62
Peak Hill 1			As	Cu Sc V Zn Mn Sr Cr Li Rb Ba	Pb Ni Co Y Zr B La	Mo	As 0.1, Rb 0.05, Sc 0.015	0.51	*1		70,000	5/5/62
2				Cu Zn Ni V Sr Mn As Li Rb Ba	Pb Co Mo Cr Sc	Zr Ga Y	Sc 0.003	2.07	2		90,000	5/5/62
Mt. Hope 1		Cu		Zn	Pb La Ni Co Bi V Cr Sn Ba	Ag Zr Sr Sc Y Mo Li	Cu 3.0.	0.37	21		5,000	6/5/62
2			Cu	Ni Bi Zn Cr Rb La	Pb Sc Co Y V Mn Zr Sn Li Ba	Ag Mo Sr	Cu 0.9, Rb 0.01, Sc 0.0012	0.37	58		5,000	6/5/62
3		Cu		Bi Zn Mn Cr La	Pb Ni Co V Y Zr Sn Ba Sc	Ag Mo Li Sr	Cu 1.1, Sc 0.0025	0.38	44		7-10,000	6/5/62
4			Cu	Zn Mn As Ba	Cr V Y Bi La Co Zr Sn Sc Ni	Pb Ag Mo Li Sr	Cu 0.4, As 0.05, Sc 0.0012.	0.31	9		7-10,000	6/5/62
5		Cu	Mn	Zn Ce Sn Rb Ba Sr Y La Nd	Pb Sc Ni Li Co Bi V Mo Cr Zr	Ag Ga B	Cu 3.0, Mn 0.1, Rb 0.05 Sc 0.004, Y 0.02, La 0.08 Nd 0.05	0.13	23		1,000	6/5/62

* Less than

SURVEY OF MINERAL RESOURCES IN TAILINGS

STATE : N.S.W.

Sample Location and Mark	Quatitative Analysis by Emission Spectroscopy - %						Semi-Quantitative Analyses by Emission Spectroscopy - %	Chemical Analysis		Radio activity	Tonnage Est. in Dump	Date Sampled
	Major 100-10	Minor 10-1	Heavy Trace 1-0.1	Trace 0.1-0.01	Faint Trace 100-10 p.p.m. 0.01-0.001	Very Faint Trace 10-1 p.p.m. 0.001-0.0001		S %	Se p.p.m.			
Mt. Royal Tottenham 1			Cu As	Zn Rb Ba	Pb Sn Ni Li Bi V Mn Mo Sb Cr La Co	Ag Zr Sr Sc Y	Cu 0.15, As 0.25, Rb 0.02.	1.33	8		2,500	7/5/62
2			Cu As	Rb	Pb Ba Ni Mn Co Li Bi Y V Sb Zn Cr	Ag Mo Zr Sr Sc	Cu 0.15, As 0.1, Rb 0.025.	1.23	8		2,500	7/5/62
3			Cu	As Co Rb Ba	Pb Li Zn Sn Mn B Cr V Bi Ni Mo	Ag Zr Sr Sc Y	Cu 0.5, As 0.06, Rb 0.015	0.26	6		2,500	7/5/62
Mineral Hill 1		Pb	Cu Sb Zn As	Ag Ba Mn	Ni Co Mo Cr Cd Li V	Ge V Zr	Pb 1.5, Cu 0.7, Zn 0.25 Sb 0.25, As 0.1, Ag 0.04.	0.10	*1		1,500	8/5/62
2	Pb	Cu	As Sb Zn	Ni Ag Mo Mn Ba	Co Cr Cd Li Y	Ge V Zr Sr Sc	Pb 10.0, Cu 1.2, Sb 0.5 Zn 0.3, As 0.15, Ag 0.03	0.07	1		1,500	8/5/62
Bobadah 1		Pb	Cu Zn	La Mn Sb As Ba	Cr Sc Ag Bi Ni Y Mo Zr Sn Sr Li	V Co	Pb 2.0, Cu 0.4, Zn 0.2, Sb 0.015, As 0.015, Ag 0.002, Sc 0.0015	0.10	4		4,000	9/5/62
2		Pb	Cu Zn	Mn Sb Rb Ba La Nd Ce	Cr Sc V Y Bi Ni Zr Sn Li Sr	Ag Co Mo In	Pb 4.0, Cu 0.7, Zn 0.2, Rb 0.05, Sb 0.01, Sc 0.005	0.31	5		1,000	9/5/62
3		Pb	Cu Zn	Ag Rb Ba	Ni La Co Bi Sb Cr Sn Li Y	V Mo Zr Cd In Sr Sc	Pb 5.0, Cu 0.75, Zn 0.3, Rb 0.01, Ag 0.01	0.30	3		1,000	9/5/62
Nymagee 1		Cu	Pb Zn	Mn Cr Bi As Cs Rb Ba La	V Co Mo Zr Sn Li Sr Y	Ag Ni B Be In Ge Sc	Cu 3.0, Pb 0.6, Zn 0.2, Rb 0.07, As 0.05, Cs 0.01	6.02	*1	∞	small-flue dust	9/5/62
Shuttleton Crowl Creek Mine 1		Cu		Zn Mn Zr Li Rb Nd Ba Ce Sr Y La	Pb Cr V Bi Ni Co Sn Sc	Ag Mo Be	Cu 4.0, Rb 0.05, Li 0.025 Sc 0.008, Y 0.02.	0.71	10		1,500	9/5/62
2		Cu		Zn Nd Mn Ce Li Rb Ba Sr Y La	Pb Sc Cr V Bi Ni Co Zr Sn	Ag Mo B	Cu 7.5, Rb 0.08, Sc 0.003 Y 0.015	0.20	8		3,500	9/5/62
3			Cu Mn	Pb Zn Li Rb Ba	Ni Sr Co Sc Bi La V Y Mo Cr Zr Sn	Ag Ga	Cu 0.3, Mn 0.1, Rb 0.07 Li 0.04, Sc 0.005	0.76	8		3,500	9/5/62
Canbelego M. Boppy Mine 1			Rb Pb Mn Zn	Cu Cr Li Ba La	Ni Co V Y Sb Zr Cd Sr Sc	Ag B Sn Be Ga	Pb 0.18, Zn 0.5, Mn 0.1, Rb 0.1, Li 0.04, Sc 0.003	1.25	*1	None Detected at Limit Equivalent to 0.002% U_3O_8	70,000	10/5/62
2			Zn	Pb Mn Sb As Li Rb Ba La	Cu Sc Cd Y Cr Nd V Ni Zr Sn Sr	Ag Co B	Zn 0.8, Rb 0.06, Li 0.04, As 0.02, Sb 0.01, Sc 0.003	1.14	1		38,000	10/5/62
3			Zn	Pb Mn As Li Rb Ba La	Cu Sc Cr Nd V Sb Y Ni Zr Sn Sr	Ag Be Co B	Zn 0.5, Rb 0.05, As 0.015, Sc 0.003	0.24	*1		117,000	10/5/62
4			Pb Zn Mn Rb	Cu As Li Ba La	Ni Sc Co Y V Sb Cr Nd Zr Cd Sr B	Ag Mo	Zn 0.4, Pb 0.15, Mn 0.1 Rb 0.1, Li 0.03, Sc 0.003	0.86	*1		14,000	10/5/62
5			Pb Zn Rb Ba	Mn As Li La	Cu B Cd Cs Cr Sn V Sr Sb Sc Ni Y Co Nd Zr	Ag Mo Ga Be	Zn 0.7, Pb 0.3, Rb 0.12, As 0.05, Li 0.04, Sc 0.003 Ba 0.15	0.88	*1		22,000	10/5/62

* Less than

SURVEY OF MINERAL RESOURCES IN TAILINGS

STATE : N.S.W.

Sample Location and Mark		Qualitative Analysis by Emission Spectroscopy - %						Semi-Quantitative Analyses by Emission Spectroscopy - %	Chemical Analysis		Radio activity	Tonnage Est. in Dump	Date Sampled
		Major 100-10	Minor 10-1	Heavy Trace 1-0.1	Trace 0.1-0.01	Faint Trace 100-10 p.p.m. 0.01-0.001	Very Faint Trace 10-1 p.p.m. 0.001-0.0001		S %	Se p.p.m.			
Girilambone	1		Cu		Zn Mn Li Rb Ba Y La Nd Ce	Pb Cr Sr V Sc Ni Co Mo Zr W Sn	Ag	Cu 4.0, Rb 0.01 Sc 0.007 Y 0.015	0.25	14		1,500	10/5/62
	2			Cu	Zn As Y La	Pb Sc Mn Sr Cr Nd V Li Ni Co Ba Mo Zr	Ag Sn	Cu 0.75, As 0.04, Sc 0.005, Y 0.015	0.40	14		2,000	10/5/62
	3			Cu	Zn As Li Ba Sr La	Pb Sc Mn Y Cr Nd V Ni Co Mo Zr	Ag Sn	Cu 0.4, As 0.025, Sc 0.0025	0.19	13		10,000	10/5/62
	4			Cu	Zn Ce Mn As Li Cs Rb La Nd	Pb Sc Cr Y V Sr Ni Co Mo Zr Sn Ba	Ag Bi Ga B	Cu 0.8, Rb 0.01, As 0.01 Sc 0.005	0.35	8		3,500	10/5/62
Bodangora	1			Cu Pb Zn	Mn Cr V Sb As W Rb Sr Ba	Cd Bi Ni Co Mo Li Sc La	Ag Zr Ge Y	Cu 0.3, Pb 0.2, Zn 0.2 W 0.03, Sb 0.02, As 0.02 Rb 0.015, Sc 0.003	0.45	1		70,000	11/5/62
	2			Cu Pb Zn	Mn Cr Sb As Ni W Rb Sr Ba	Cd Sc V Ag Bi Co Mo Sn Li	Zr Y	Cu 0.5, Pb 0.5, Zn 0.25 W 0.08, As 0.05, Sb 0.01 Ag 0.001, Sc 0.006.	0.93	*1		1,500	11/5/62
	3			Cu Zn Pb	Mn Cr Sb As Rb Ba Sr	Cd Sc V Bi Ni Co Mo W Li	Ag Zr Sn Y	Cu 0.5, Zn 0.5, Pb 0.3 Rb 0.01, As 0.01, Sb 0.01 Sc 0.0015	2.23	*1		12,000	11/5/52
	4			Cu Zn Pb	Mn Cr Sb As W Ba Sr	Cd V Bi Ni Co Mo Li Y Sc	Ag Zr	Cu 0.4, Pb 0.4, Zn 0.2 As 0.02, Sb 0.015, W 0.02 Sc 0.002	2.86	*1	None Detected at Limit Equivalent to 0.002% U_3O_8	12,000	11/5/62
Howell Conrad Mine	1			Pb As Sn	Cu Zn Li Rb Ba	Mn Cr Ag Bi Sb Ni Mo Y B	Co Zr Sr Sc	As 0.6, Pb 0.3, Sn 0.25 Rb 0.04, Li 0.025, Ag 0.003	0.19	3		21,000	15/5/62
	2			Pb Sn As	Cu Zn Li Rb Ba	Mn Cr Ag Bi Ni B Y	V Co Mo Zr Be Sr Sc	Pb 0.6, As 0.5, Sn 0.25, Rb 0.025, Ag 0.0025	0.24	2		21,000	15/5/62
Emmaville Webb's Consols Mine	1		Pb Zn As	Cu Mn Rb	Zr Li Ba Y	Cr Cs Ag Sc Bi La Sb Ni Co Sr Mo Sn In Ga	V	Zn 8.0, As 4.0, Pb 3.0, Mn 0.5, Rb 0.3, Cu 0.15, Li 0.05, Ag 0.005, Sc 0.0012, Y 0.02	4.60	1		300	15/5/62
	2	Zn	Pb As	Cu Mn Rb	Cd V Li Cs Ba Y	Cr Sn Ag In Bi Sr Sb La Ni Co Mo Zr	Ga Sc	Zn 15.0, As 7.0, Pb 2.0 Mn 0.3, Rb 0.3, Cu 0.2, Li 0.05, Cs 0.01, Ag 0.0025, Cd 0.015, Y 0.02	7.14	1		2,000	15/5/62
Tent Hill Ottery Mine	1		As Sn		Pb Li Rb Ba	Cu La Zn Sr Mn Sc Cr V Bi Ni B	Ag Co Mo Zr Be Ge Y	As 1.0, Sn 2.0, Rb 0.08, Li 0.02, Sc 0.0015	0.15	*1		4,500	16/5/62
	2		As	Pb Sn Rb	Cu Zn Mn Bi Li Cs Ba La	Cr Sc V Y Ag Sb Mo Zr B Sr	Ni Co	As 2.0, Pb 0.5, Sn 0.3, Rb 0.12, Cs 0.015, Ag 0.002, Sc 0.002	1.81	*1		4,500	16/5/62
	3		As	Sn	Cu Pb Zn Li Rb Ba	Mn La Cr V Bi Ni Mo Zr Sr B	Ag Co Sc Y	As 1.0, Sn 0.6, Rb 0.07	0.83	1		4,500	16/5/62
	4		As	Sn	Cu Zn Sb Rb Ba	Pb Mn B Cr Bi Ni Y Co Mo Li V	Ag Zr Be Sr	As 6.0, Sn 1.2, Sb 0.01 Rb 0.05	2.73	*1		1,500	16/5/62
	5		Sn	As Rb Pb	Cu La Zn Li Ba	Cr V Y B Bi Ni Zr Co Mo Mn Cs Sr Sc Ag	-	Sn 1.0, As 0.8, Rb 0.1, Pb 0.3, Sc 0.0015	0.64	*1		1,500	16/5/62

* Less than

SURVEY OF MINERAL RESOURCES IN TAILINGS

STATE : N.S.W.

Sample Location and Mark		Qualitative Analysis by Emission Spectroscopy - %						Semi-Quantitative Analyses by Emission Spectroscopy - %	Chemical Analysis		Radio activity	Tonnage Est. in Dump	Date Sampled
		Major 100-10	Minor 10-1	Heavy Trace 1-0.1	Trace 0.1-0.01	Faint Trace 100-10 p.p.m. 0.01-0.001	Very Faint Trace 10-1 p.p.m. 0.001-0.0001		S %	Se p.p.m.			
Emmaville Webb's (Collison's) Silver Mine	1		Zn	Cu Pb Mn Sb As Sn Rb	Ag V La Li Cd Cs Ba Sc Nd Y	Ni Co Mo Cr Zr Sr	Be Bi Ga	Zn 2.5 Cu 0.8 As 0.7 Rb 0.5 Li 0.06 Ag 0.03 Sc 0.015 Mn 0.3 Sb 0.25 Sn 0.15 Pb 0.1 Cs 0.04 Y 0.015 Cd 0.015	1.27	4		10,000	16/5/62
	2		Zn As	Cu Pb Mn Sb Rb	Sn Y Cd La Ag Ce Zr Li Nd Cs Ba Sc	V Bi Ni Mo W Sr	Co Ga	Zn 3.0 As 2.0 Cu 0.9 Rb 0.25 Mn 0.2 Pb 0.1 Li 0.06 Ag 0.04 Sb 0.4 Cs 0.015 Sc 0.015 Y 0.015.	1.40	4		10,000	16/5/62
	3		Zn As Cu Sb	Sn Pb Mn Rb	Cs Nd Cd La Ag V Zr Li Ba Ce Sc	Cr Ni Co Mo W Sr Y	Bi Ga In	Zn 4.0 As 1.5 Sb 1.0 Cu 1.0 Pb 0.8 Mn 0.4 Sn 0.25 Y 0.002 Rb 0.2 Ag 0.04 Li 0.06 Cd 0.025 Sc 0.015 Cs 0.015	0.18	1		2,500	16/5/62
	4		Zn As Cu	Rb Pb Mn Sb Ba	Cd Sn Ag Sr Li Cs Y La Nd	Cr V Bi Ni Co Mo Zr Sc	Ga	As 5.0 Zn 3.0 Cu 1.0 Pb 0.5 Mn 0.5 Sc 0.009 Rb 0.3 Sb 0.3 Li 0.06 Cs 0.03 Ag 0.03 Ba 0.25 Y 0.015	3.00	*1		2-500	16/5/62
Torrington Curnow's Mine	1			Sn Rb	Ni Mn Li Ba Y La	Cu Pb Zn Cr Be Sr Sc	Co V Mo Zr Ga	Sn 0.25 Rb 0.1 Li 0.05 Sc 0.0015 Y 0.015	0.059	1		1,500	17/5/62
	2			Sn Rb	Zn Mn Li Cs Ba	Cu Pb Ni Cr Sc Y La	Be Ag Co V Mo Zr Ga Sr B	Sn 0.15 Rb 0.15 Li 0.04 Cs 0.015 Sc 0.0012	0.022	1	None Determined at Limit Equivalent to 0.002% U_3O_8	1,000	17/5/62
	3			Sn Rb	Pb Zn Mn Li Ba Y La Ce	Cu Ni Mo Cr Cs Sc Nd	Ag Co V Zr Ga Sr	Sn 0.5 Rb 0.18 Li 0.05 Sc 0.002 Y 0.015	0.028	2		500	17/5/62
	4		Sn	Rb	Cu Ce Pb Zn Nd Mn Li Cs Ba Y La	V Mo Ga Sr Sc	Be Ag Ni Co Cr Zr	Sn 2.0 Rb 0.2 Li 0.05 Cs 0.015 Sc 0.007 Y 0.03	0.004	1		1,000	17/5/62
Torrington Fielder's Hill Mine	1			W	Mn Bi Li Rb Y	Cu Sc Pb La Zn Ni Mo Cr Be Ba	Ag V Co Zr B Ge Sr	W 0.1 Li 0.04 Bi 0.04 Rb 0.01 Sc 0.0012 Y 0.03	1.04	1		4,000	17/5/62
Torrington Bismuth Mine	1				Be Cu Pb La Ni Bi W Y Li Rb	Zn Cr Mn Ba Sc	Ag Co V Mo Zr B Ge Sr	Be 0.03 Bi 0.08 W 0.05 Li 0.04 Rb 0.025 Sc 0.0015 Y 0.02	0.006	*1		2,400	17/5/62
	2			W	Be Ce Ni Mn Li Rb Bi Y Nd La	Cu Pb Sc Zn Mo Cr Zr B Ge	Ag Co V Sr	Bi 0.05 W 0.25 Be 0.02 Y 0.04 Li 0.02 Rb 0.015 Sc 0.002	0.007	*1		3,000	17/5/62
Drake E.R. & S Mill	1			Cu Zn Pb	Mn Rb Ba	Ni V Mo Bi Li Sc Y	Ag Co Cr Zr Sr	Pb 0.2 Cu 0.12 Zn 0.1 Rb 0.015 Sc 0.002	0.14	7		2,500	21/5/62
	2			Cu Pb Zn	Mn Rb Ba	Ni Sc Co V Mo Y Cr Bi Cd Li	Ag Zr Ga Sr	Pb 0.8 Cu 0.7 Zn 0.3 Rb 0.04 Sc 0.004	0.63	10		2,000	21/5/62
West Wyalong	1			Pb Zn Rb	Cu Mn Li Ba La	Ni Co V Y Cr Zr B Sr Sc	Ag Bi Mo Ga	Pb 0.18 Zn 0.15 Rb 0.12 Sc 0.008	0.34	*1		4,500	29/5/62
	2			Pb Mn	Cu Zn Ni La Co V As Li Rb Ba	Cr Zr Sr Sc Y	B Ag Mo Bi Ga	Mn 0.25 Pb 0.1 As 0.05 Rb 0.04 Sc 0.006	0.27	2		6,000	29/5/62

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SURVEY OF MINERAL RESOURCES IN TAILINGS

STATE : N.S.W.

Sample Location and Mark	Qualitative Analysis by Emission Spectroscopy - %						Semi-Quantitative Analyses by Emission Spectroscopy - %	Chemical Analysis		Radio activity	Tonnage Est. in Dump	Date Sampled
	Major 100-10	Minor 10-1	Heavy Trace 1-0.1	Trace 0.1-0.01	Faint Trace 100-10, p.p.m. 0.01 -0.001	Very Faint Trace 10-1 p.p.m. 0.001-0.0001		S %	Se p.p.m.			
Mt McDonald 1 Milburn Creek Mine				Cu Pb Zn Sr V La Cr Mn Rb Ba	Ni Co Mo Bi Sn Li Sc Y	Ag Zr	Rb 0.015 Sc 0.003	0.14	2		Small	29/5/62
2			Cu	Zn Rb Ba Sr	Pb Sc Ni La Co Sn V Mo Cr Mn Bi	Ag Zr Li Y	Cu Ql Rb 0.015 Sc 0.001	0.71	73		Small	29/5/62
Frogmore 1 Wolfram Mine			Cu As W Rb	Zn Mn Bi B Li Cs Ba	Pb Sc Ag La Ni Co V Mo Sr Cr Sn	Zr Y	Cu 0.3 W 0.4 As 0.15 Rb 0.15 Cs 0.02 Bi 0.05 Sc 0.0015 Ag 0.001	0.42	2		4,250	30/5/62
2			Bi W	Cu Mn B Li Rb Ba	Pb Zn Ag Ni Mo Cr	Co V Zr Sn Sr Sc Y	W 0.25 Bi 0.15 Rb 0.03 Ag 0.001	0.049	3		4,250	30/5/62
3			As W	Zn Mn Bi B Li Rb Ba Cu	Pb Ag Ni Cr Sn Sr Y La	Co V Mo Zr Sc	W 0.5 As 0.5 Rb 0.05 Bi 0.05 Ag 0.001 Sc 0.001	0.08	3		1,300	30/5/62
4		W	Bi	Cu Pb Zn Sr Mn B Li Rb La Ba	Ag Nd Ni Co V Y Mo Cr Sn As Sc	Be Zr	W 1.0 Bi 0.12 Rb 0.07 Li 0.02 Ag 0.001 Sc 0.003	0.025	1		7,500	30/5/62
Frogmore 1 Copper Mine		Cu		Pb Zn Mn Rb Ba	Ag Sr Ni Sc Co Y V La Cr Zr Bi Li	Mo Sn	Cu 1.0 Rb 0.01 Ag 0.005 Sc 0.005	0.42	58		200	30/5/62
Kangiara 1		Cu Pb Zn	Rb Ba	Ag Ce Mo Mn Nd Cd Li Sb Y La	Ni Sc Co V Cr Zr Bi Ga Sr In		Pb 8.0 Zn 7.0 Cu 2.0 Rb 0.15 Y 0.015 Ba 0.4 Ag 0.03 Cd 0.015 Sb 0.03 Sc 0.004	6.46	*1	None Detected at Limit Equivalent to 0.002% U_3O_8	2,600	30/5/62
2		Pb	Cu Zn Rb	Ag Mo Li Cs Ba	Ni Co V Cr Mn Bi Ga	Zr Sn In Sr Y	Pb 2.0 Cu 0.7 Zn 0.2 Rb 0.2 Ag 0.015 Cs 0.01	0.76	1		1,200	30/5/62
3		Pb Zn	Cu Rb Ba	Ag La Ni Nd Mo Y Mn Sb Ce Bi Cd Li	Co Sc V Cr Zr Ga Sn Cs Sr	In	Pb 6.0 Zn 2.0 Cu 0.9 Rb 0.2 Sc 0.004 Li 0.025 Ag 0.025 Cd 0.015 Sb 0.02 Y 0.015 Ba 0.25	2.54	1		1,000	30/5/62
4		Pb Zn Cu	Rb Ba	Ag Mo Sb Cd Li Y La Ce	Ni Sc Co Nd V In Cr Mn Zr Bi Sr Sn	Ga	Pb 7.0 Zn 4.0 Cu 1.2 Rb 0.15 Sc 0.004 Ag 0.04 Sb 0.03 Li 0.02 Cd 0.015 Y 0.01 Ba 0.2	4.82	*1		1,000	30/5/62
5	Pb	Cu Zn	Rb Ba	Ag Ce Mo Mn Sb Cd Li La Nd	Ni Sr Co Cs Sc V In Cr Y Zr Bi Ga Sn		Pb 20 Zn 4.0 Cu 4.0 Rb 0.1 Ag 0.035 Sb 0.05 Li 0.025 Cd 0.012 Sc 0.006 Ba 0.5	5.49	1		1,500	30/5/62
Broken Hill North Broken Hill Ltd. 1		Mn Zn Pb		Li Rb Sr Ba As Sb W Cu	Co Ag Cd V Zr Cr Sn	Ni Mo Bi Y	Mn 5 Zn 4 Pb 3 Li 0.03 Rb 0.1 Ba 0.1 As 0.02 Sb 0.04 Ag 0.005	4.25	*1		100,000	August 62
2		Mn Zn	Rb Ba Pb	Li As Sb W Cu	Co Ni Ag Cd V Zr Sr Cr Sn	Mo Ge Bi Y	Mn 7 Zn 4 Pb 0.8 Rb 0.12 Ba 0.1 Li 0.025 As 0.025 Sb 0.015 W 0.06 Ag 0.003	1.04	*1		1,500,000	August 62
3		Mn Zn	Pb	Li Rb Ba Cu	Ni Co Ag Cd V Sr As Sb Cr W	Mo Ge Y Sn Zr	Mn 5 Zn 3 Pb 0.8 Li 0.03 Rb 0.1 Ag 0.0025	0.72	1		1,500,000	August 62
4		Mn Zn	Rb Ba Pb	Li As Cu	Co Ag Cd V Zr Sr Sb Cr W Sn	Ni Mo Ge Y	Mn 5 Zn 2.5 Pb 0.7 Rb 0.12 Ba 0.12 Li 0.035 As 0.025 Ag 0.0015	0.83	1		1,100,000	August 62

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SURVEY OF MINERAL RESOURCES IN TAILINGS

STATE : N.S.W.

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	Major 100-10	Minor 10-1	Heavy Trace 1-0.1	Trace 0.1-0.01	Faint Trace 100-10 p.p.m. 0.01-0.001	Very Faint Trace 10-1 p.p.m. 0.001-0.0001		S %	Se p.p.m.			
Broken Hill North Broken Hill Ltd. 5		Mn Zn Pb	Cu	Rb Ba As Sb Cr	Co Ni Ag Cd Mo V Li Sr W Sn	Ge Bi Y Zr	Mn 5 Zn 7 Pb 3 Cu 0.1 Rb 0.05 As 0.07 Sb 0.04 Ag 0.008	2.3	*1		600,000	August 62
6		Mn Zn Pb	Cu	Ag Li Rb Sr Ba As Sb	Co Cd Mo Cr W Sn	Ni V Bi Y Zr	Mn 3 Zn 5 Pb 6 Cu 0.1 Ag 0.012 Li 0.02 Rb 0.1 As 0.025 Sb 0.03	8.4	*1		150,000	August 62
7		Mn Zn	Rb Pb	Li Ba As Cu	Co Ni Ag Cd V Sc Zr Sr Sb Cr W Sn	Mo Ge Y	Mn 7 Zn 2.2 Rb 0.12 Pb 0.8 Li 0.03 Ba 0.09 As 0.03 Ag 0.0025	0.61	*1		40% of 300,000 per year. Balance sent underground as fill.	August 62
Broken Hill Zinc Corporation Ltd. and New Broken Hill Consolidated Ltd. 1	Mn	Zn	Pb	As Ba Cr Cu Rb Sb Sr W	Ag Cd Co Ni Sn V Y	B Bi Li Mo Sc	Mn 20 Zn 4 Pb 0.7 Rb 0.07 W 0.03 Ag 0.0015	0.87	*1			February 1964
2	Mn	Zn	Pb	As Ba Cr Cu Rb Sb Sr W	Ag Cd Co Mo Ni Sn V	B Bi Li Sc Y	Mn 10 Zn 3 Pb 0.6 Rb 0.035 W 0.02 Ag 0.0012	0.71	*1			
3	Mn	Zn	Pb	As Ba Cd Cr Cu Rb Sb Sr W	Ag Co Li Ni Sn V	B Bi Mo Sc Y	Mn 10 Zn 5 Pb 0.7 Rb 0.08 W 0.03 Cd 0.02 Li 0.012 Ag 0.0018	2.10	*1	0.002% U_3O_8	22,000 per 4 weekly period 58,000 sent underground as fill. Based on 128,000 tons milled for period.	
Captain's Flat Lake George Mines Ltd. Keating's Area		Zn Pb	As Cu	Rb Ba Sb	Mn Cr Ni Co Ag Cd Bi Sn W Mo	Sr V B	Zn 8 Pb 1.2 As 0.2 Cu 0.3 Rb 0.035 Ba 0.02 Ag 0.001	34.2	*10	None Detected at Limit Equivalent to 0.00	300,000	November 1963
Ardlethan 1		B	As Sn Pb Cu	Bi Li Rb Cr W Zn	Ni Ag Sr Ba Mn Sb	Co Mo V Be Ge Y Zr	B 1.5 As 0.8 Sn 0.6 Pb 0.6 Cu 0.1 Bi 0.02 Li 0.09 Rb 0.09 W 0.1 Ag 0.0012	0.83	2		21,700	Oct-Nov. 1962
2		B	As Sn Pb Cu	Bi Li Rb Mn Sb Cr W Zn	Co Ni Ag Mo V Zr Sr Ba	Cd Be Ge Y	B 3 As 1 Sn 1 Pb 1 Cu 0.12 Bi 0.05 Rb 0.1 Li 0.045 Sb 0.02 Ag 0.004 W 0.08	1.45	8		24,700	Oct-Nov. 1962
3			Rb As B Sn Pb	Bi Li Cr W Zn Cu	Ni V Zr Ba Mn Sb Sr	Co Ag Cd Mo Be Y	B 0.8 As 0.7 Sn 0.5 Pb 0.25 Rb 0.12 Bi 0.03 Li 0.04 W0.06 Ag 0.001	0.27	3		36,800	Oct-Nov. 1962
4			As B Sn Pb	Bi Li Rb Cr W Zn Cu	Sr Ba Mn Sb	Co Ni Ag Mo V Y Zr	B 1 As 0.7 Sn 0.3 Pb 0.25 Rb 0.05 W 0.025	0.29	3		10,600	Oct-Nov. 1962
Cobar 1			Cu	Rb Mn Cr Zn Pb	Co Ni V Bi Li Sr Ba W Sn	Ag Mo Ge Zr B	Cu 0.3 Rb 0.015	0.78	9		40,000	August 62
2			Cu	Bi Rb Mn W Zn	Co Li Sr Ba Cr Sn Pb	Ni Mo V Ge Zr	Cu 0.12 Bi 0.03 Rb 0.012 W 0.02	0.89	11		300,000	August 62
3			Pb	Bi Mn As W Zn Cu	Ba Sb Cr Sn	Co Ni Ag Mo V Ge Zr Li Sr	Pb 0.3 Bi 0.04 As 0.1 W 0.03 Cu 0.1	0.06	20		2,000	August 62
4			Cu	Bi Mn W Zn Pb	Co Ni Li Ba As Cr Sn	Ag Mo V Ge Zr Sr	Cu 0.15 Bi 0.04 W 0.03	0.72	25		1,500,000	August 62
5			Cu	Bi Mn W	Co Ni Mo Li Ba As Cr Sn Zn Pb	Ag V Ge Zr Sr	Cu 0.2 Bi 0.04 W 0.02	0.58	21		120,000	August 62

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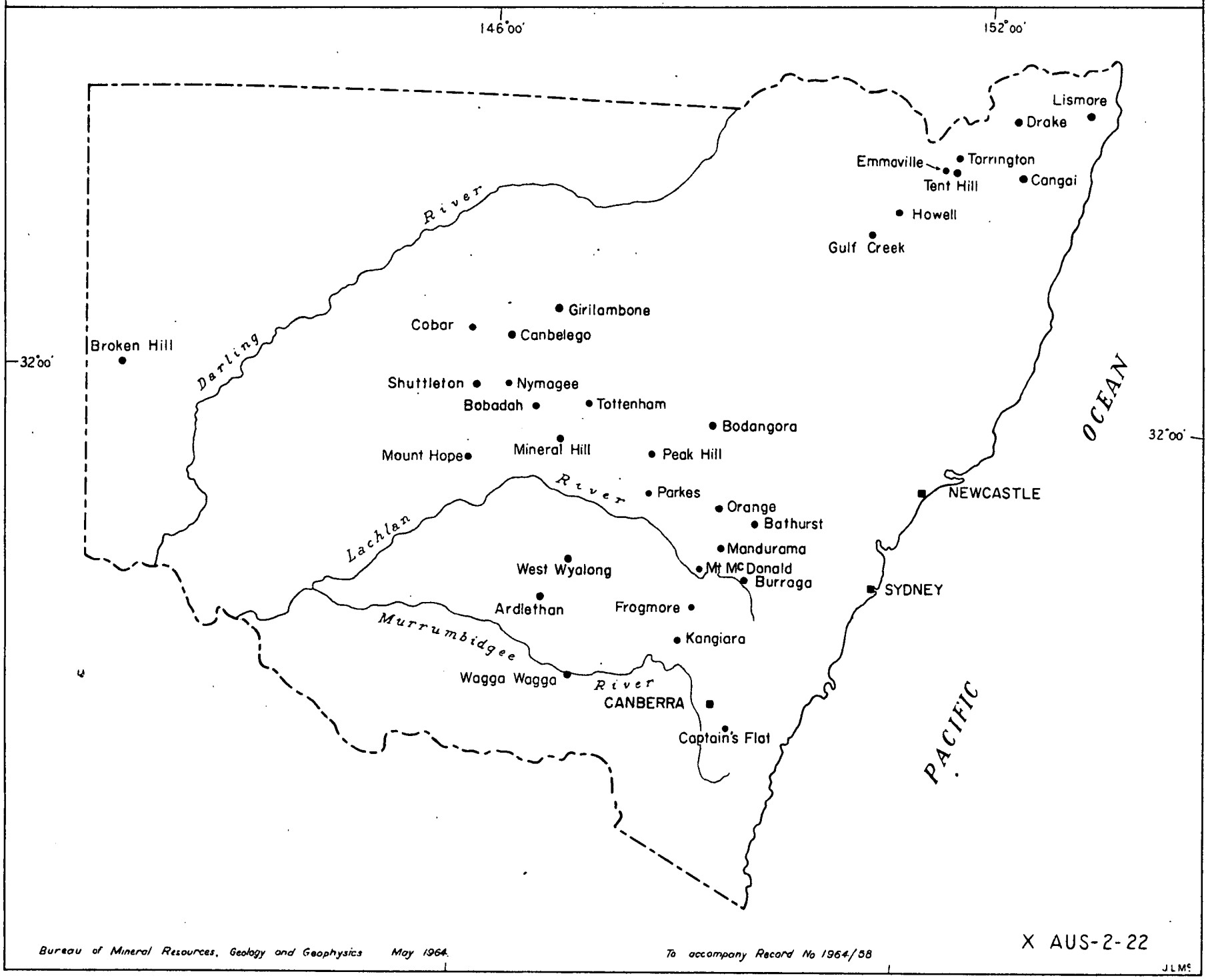
Locality Map

SURVEY OF MINERAL RESOURCES IN NEW SOUTH WALES TAILINGS DUMPS

By R.W.L.King.

100 0 100 200

MILES



Bureau of Mineral Resources, Geology and Geophysics May 1964.

To accompany Record No 1964/58

X AUS-2-22

J.L.M.