CENTURY Zn-Pb-Ag DEPOSIT, NORTHWEST QUEENSLAND

P.D. Agnew

Rio Tinto Exploration Pty Limited, 1 Research Ave, Bundoora, VIC 3083

LOCATION

The Century Deposit is located approximately 250 km NNW of Mt Isa in NW Queensland (Figure 1) at 18º43'33.11"S, 138º36'3.04"E: Lawn Hill 1:250 000 map sheet (SE54-09).

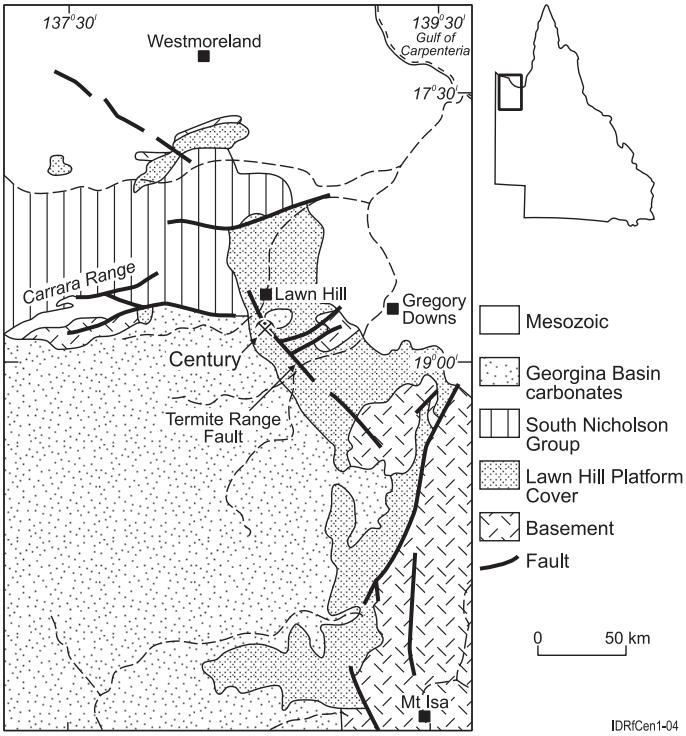

Figure 1. Location and regional geological setting of the Century deposit after Ord et al., (2002).

DISCOVERY HISTORY

The deposit was found in 1990 by CRA Exploration Pty Limited by drilling a soil geochemical anomaly on a regional gravity - magnetic - soil geochemistry traverse. An earlier conceptual study had identified the Lawn Hill area to have potential for base metal discoveries, with a prominent domal annulus of Cambrian limestone thought to be particularly prospective. Two 20 km long traverses were soil sampled across the dome, with one passing beneath its SW margin where it crossed the Termite Range Fault. There was a prominent Zn-Pb soil anomaly near the SW end of this traverse. This was directly over the surface projection of the Century orebody, concealed beneath barren Proterozoic hangingwall sediments and the unconformably overlying Cambrian limestone. Subsequent infill soil sampling confirmed the anomaly over the Cambrian limestone near the unconformity as well as over a strongly leached, laminated Proterozoic siltstone outcrop, lacking gossan. Rock chip samples, collected earlier from this outcrop, contain 1-2% Pb and Zn and up to 30 ppm Ag. The outcrop was an exposed section of the Century mineralization, later named Discovery Hill, but strong leaching and the lack of gossanous iron oxides led to a subdued geochemical and visual expression of the low sulphur mineralization. Geochemical anomalies on the nearby Cambrian limestone could have been from Cambrian carbonate-hosted Pb and Zn, which was not considered an attractive exploration target. However, the presence of anomalous Proterozoic outcrop near the unconformity on Discovery Hill and comparable soil results from Watsons Lode, a nearby, small, high-grade, discordant Pb-Zn deposit, led to drilling of the soil anomaly. The discovery hole was collared on Proterozoic hanging wall sediments near the anomalous Cambrian unconformity and intersected 27 m at 6.3% Zn. The sulphides are so fine grained that mineralization was not readily visible in the drill chips but panning revealed some galena.

PHYSICAL FEATURES AND ENVIRONMENT

The deposit is located in moderately incised, undulating rocky terrain

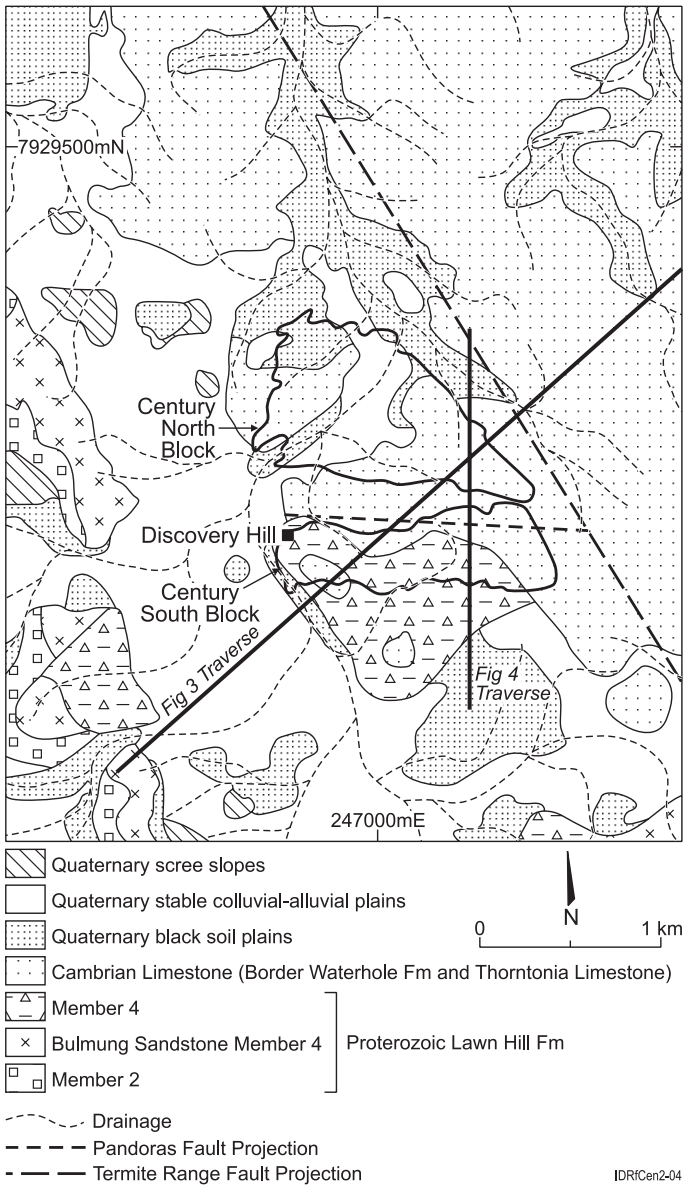

Figure 2. Simplified regolith map of the Century area (Agnew, 1997). Surface projection of Century Zn-Pb-Ag deposit shown in outline and the locations of traverses in Figures 3 and 4.

flanked by flat depositional plains. The climate is semi-arid with an average annual rainfall of approximately 400-500 mm falling mostly in the monsoonal summer months. Temperatures range from 25-37ºC in January and 10-25ºC in July. Vegetation is sparse, consisting mainly of *Eucalyptus* and *Acacia* shrubs with spinifex (*Triodia* spp.) and ephemeral grasses. Zinc weed *(Polyarpia* spp.*)* is conspicuous on the outcropping leached mineralization.

GEOLOGICAL SETTING

The Century Zn-Pb-Ag deposit lies in the Western Fold Belt of the Mt Isa Inlier, in laminated siltstone of the Lawn Hill Formation. This is the youngest member of the Proterozoic McNamara Group, 5-10 km of fine grained clastic sediments and minor volcanic rocks that host the Mount Isa, Hilton, Hilton North and Lady Loretta base metal deposits. The geology of the deposit has been described in detail by Waltho *et al.*, (1993) and Broadbent *et al.*, (2002). The mineralization is largely concealed beneath Cambrian limestone and dolomite of the Georgina Basin, which forms a prominent 15 km diameter doughnut-shaped outlier 10 km E of the current main erosional margin of the Georgina Basin.

Century lies adjacent to a major NW trending structure, the Termite

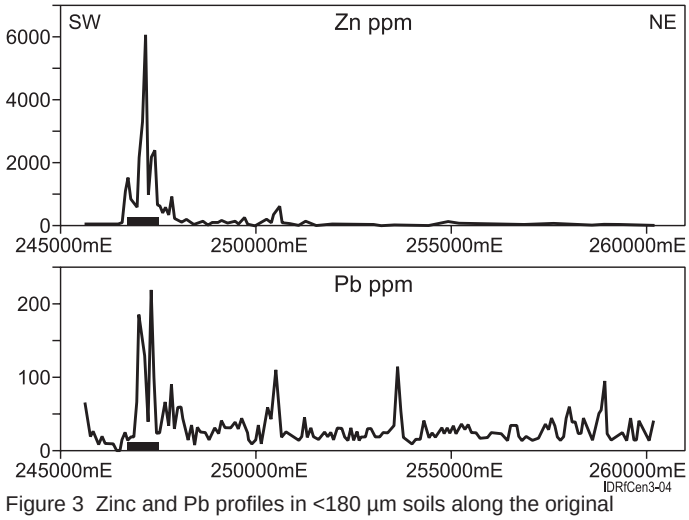

Figure 3 Zinc and Pb profiles in <180 µm soils along the original CRAE reconnaissance traverse which crossed the Century deposit. Surface projection of Century mineralization shown as a bar. Location of traverse given in Figure 2.

Range Fault. Repeated re-activation of this and associated structures have played a major role in creating the basin in which the Century deposit formed and the subsequent structural dislocation, erosion and preservation of the mineralization, (Ord *et al.*, 2002). Normal movement on Pandoras Fault, a small E-trending splay from the Termite Range Fault, breaks the Century deposit into two major blocks, the northern downthrown block preserves the mineralization and the unconformity under the Cambrian limestone. The southern block, largely stripped of limestone, exposes the hangingwall sediments with isolated remnants of the Cambrian unconformity. At the western extremity of the southern block, mineralization outcrops on Discovery Hill.

REGOLITH

All of the northern block of the Century mineralization lies concealed beneath 50-150 m of Cambrian limestone and up to 200 m of barren Proterozoic hangingwall sandstone and siltstone. Regolith on the Cambrian limestone consists of residual skeletal soils on rocky outcrops with minor, flat colluvium-alluvium filled gullies and depressions in which the present ephemeral drainage is weakly developed. The southern block is also partly covered by Cambrian limestone and barren hangingwall sediments that either outcrop on gentle scree-covered slopes or are covered by adjacent colluvial-alluvial plains with extensive black soils (Figure 2).

The Cambrian unconformity, which truncates the Century host stratigraphy, is a partly preserved regolith surface. It is gently undulating over Century but, locally, it is severely disturbed by post-Cambrian faulting. Massive to friable manganiferous ironstone rubble and minor outcrop at the Cambrian unconformity occur as isolated pods around the 15 km diameter limestone inlier. This unconformity-related manganiferous ironstone appears to have been derived from increased fluid flow along the permeable unconformity during lateritic weathering, suggesting the unconformity may be a geochemical migration pathway.

Lateritic residuum is scarce in the Century area, but less resistant lithologies such as siltstones have been leached and bleached, with some ferruginous saprolite. Proterozoic quartz-rich sandstone and Cambrian limestone are relatively fresh at the surface. Gossans occur over sulphides, particularly pyrite, in Proterozoic rocks.

MINERALIZATION

Century contains an estimated *in situ* mineral resource of 167 Mt at 8.2% Zn, 1.2% Pb and 33 g/t Ag, (Kelso *et al.*, 2001). Mineralization consists of fine-grained sphalerite, with minor galena and pyrite, in fine bedding laminae in a black shale up to 5 m thick, within a 50 m thick mineralized sequence. Mineralization is stratabound but, in detail, grade variations and Pb-Zn zonation patterns subtly transgress the stratigraphy (Ord *et al.*, 2002). The surface projection of the orebody covers approximately 1.4 km^2, separated by faulting into two major blocks and a third small block to the E. The orebody is fault-bounded on all sides and has been eroded both at the Cambrian unconformity and the present surface.

REGOLITH EXPRESSION

Stream sediments

Regional stream sediment sampling and extensive regional soil sampling after the discovery, including multi-media, partial and total digestion orientation traverses, have built a clear picture of the geochemical dispersion from Century, (Agnew, 1997). Century has a 7 x 2.5 km regionally prominent <180 µm stream sediment Zn-Pb-Cd anomaly (>99th percentile; 3512 samples). Tailings, shed from nearby discordant lode workings at Silver King, contribute significantly to this anomaly, but there are two highly anomalous 300 m^2 catchments (with 700 and 570 ppm Zn) which drain directly from Cambrian limestone over the mineralization and Discovery Hill, respectively.

Manganese, Zn, Pb and Cd are regionally anomalous in stream sediments around the large Cambrian limestone annulus that, in part, conceals the Century orebody. This is due to high lithochemical backgrounds in the carbonates, particularly from the brecciated basal units at the unconformity. Although Zn in catchments draining Century is significantly greater than elsewhere on the limestones, lower Zn-Pb stream sediment anomalies provide spurious targets unless the high background is taken into account.

Soil

The original reconnaissance line of 100 m-spaced soil samples collected over Century (Figure 3) yielded a prominent Zn anomaly comprising 17 consecutive samples at between 350 ppm and 6050 ppm, including 6 consecutive samples (covering 600 m) averaging 2800 ppm. These highly anomalous samples were from Cambrian limestone between the N and S ore blocks, near the surface projection of Pandoras fault. Lead data were more erratic and gave a spiky anomaly (120-280 ppm) coincident with the peak of the Zn anomaly (Figure 3). The location of the Zn anomaly on the Cambrian limestone initially diminished its

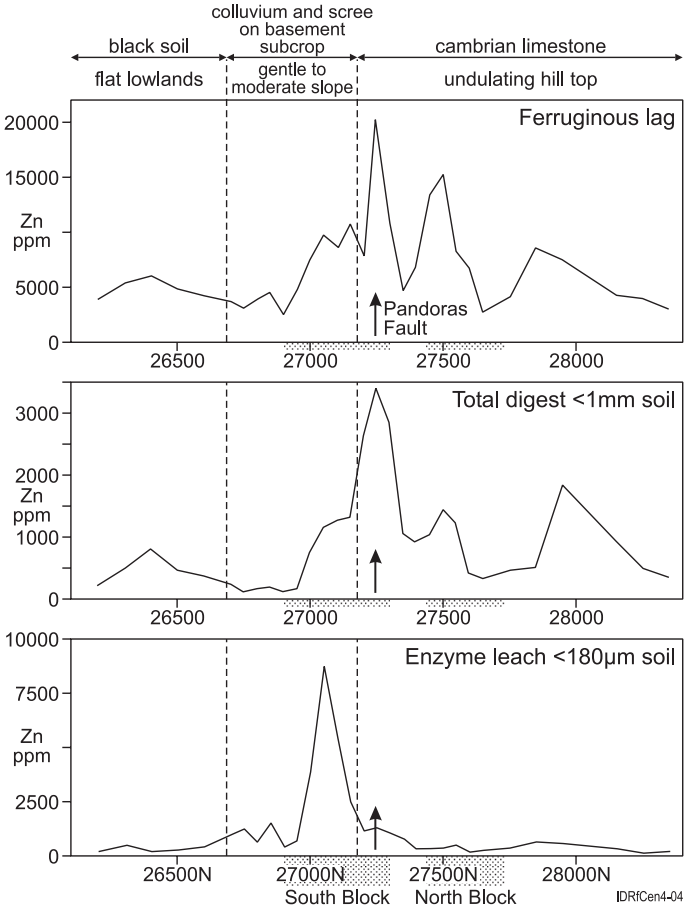

Figure 4 Multi-media geochemical orientation soil and high iron lag Zn profiles over Century Zn-Pb-Ag deposit. Regolith and landform domains are labelled on the top profile. Location of Pandoras Fault shown as a black arrow, (Agnew 1997). Location of traverse given in Figure 2; coordinates refer to a local grid.

significance, as minor Pb-Zn mineralization in the Cambrian limestone is common and was not considered a worthwhile target.

The Century mineralization shows a regionally prominent 2 x 1 km Zn anomaly (>99th percentile; 19200 samples) in <350 µm soils immediately over the orebody. Peaks of 7200 and 7000 ppm Zn occur on the Cambrian unconformity directly above Century and on the hanging wall over the southern mineralized block, respectively. Cadmium and Pb are also anomalous (>99th percentile; 19200 samples) with peaks of 34 ppm Cd and 5300 ppm Pb. More obvious Pb anomalies occur just S of the deposit on discordant lode mineralization. Anomalous Mn and P also occur with the Zn-Cd-Pb anomaly but are not prominent regionally.

Soils on Cambrian Thorntonia Limestone and carbonates of the Border Waterhole Formation have background Zn and Pb levels an order of magnitude greater than any other lithologies in the region. As with stream sediments, recognition of the high lithochemical backgrounds in soil is important in order to distinguish responses due to mineralization. Statistical correction for sample site lithology was achieved by calculation of standard scores for each subset of samples collected on the same geological unit. This effectively compensated for the high Zn and Pb background in the Cambrian carbonates without detracting from the anomaly over Century. Enzyme leach <180 µm soils give very high contrast anomalies through barren Proterozoic rocks over the S ore block but do not detect mineralization through limestone cover.

Lag

Ferruginous lag is also effective in detecting Century through carbonate cover, but is more expensive to collect and prepare than soil. Lag is swept from deflation surfaces, generally near termite mounds where termites have brought coarse material to the surface. The 1-2 mm fraction is separated in a heavy liquid (SG 2.96) to recover both the magnetic and non-magnetic ferruginous fractions (Agnew, 1994). There are spurious anomalies in ferruginous lag on black soil plains due to scavenging by Mn minerals but it gives a clear response over Century, even highlighting the gap between the N and S ore blocks (Figure 4).

A comparison of media (total mixed-acid ($HF-HClO_4-HCl-HNO_3$) digestion soil, ferruginous lag and enzyme leach soil) is shown on Figure 4 (Agnew, 1997). This orientation traverse clearly shows the peak Zn results in soils and ferruginous lag lie on the projection of Pandoras Fault on the Cambrian limestone with several additional anomalies on the Cambrian limestone up to 300 m above the mineralization. Adjacent orientation lines confirm this pattern.

Outcrop and float

Grab samples of manganiferous ironstone float and outcrop around the limestone annulus contain high Zn (1%), Pb (1700 ppm) and Cd (50 ppm) with very little Ag (<0.5 ppm). However, near Century, Zn, Pb and Cd increase sharply (up to 7.3% Zn, 6.8% Pb and 170 ppm Cd) and Ag is highly anomalous (2-48 ppm). Manganese oxides outcrop much more abundantly on the Cambrian unconformity near Century.

Anomaly patterns over the orebody suggest that the primary controls on geochemical dispersion from Century are: -

i) Physical dispersion from leached mineralized outcrop on Discovery Hill where anomalies occur in all elements in rock chips, residual soils and stream sediments.

ii) Hydromorphic dispersion along the Cambrian unconformity during lateritic weathering. This is associated with precipitation of manganiferous ironstones which carry highly anomalous Zn, Pb, Cd and Ag immediately overlying and adjacent to Century.

iii) Hydromorphic dispersion up Pandoras Fault generating anomalous soils on the Cambrian limestone overlying the orebody. This and other small structures, which are probably numerous, appear to provide conduits for dispersion from the orebody and the Cambrian unconformity, through the overlying limestone. There is also likely to be a contribution from minor Pb-Zn mineralization in the Cambrian carbonates themselves, however the abundances of Pb and Zn in soils on limestone overlying Century are an order of magnitude greater than those regionally on the Cambrian limestone.

REFERENCES

Agnew, P.D, 1997. Century Surficial Geochemistry Project Final Report. Internal report 22309, Rio Tinto Exploration Pty. Limited (unpublished).

Agnew, P.D., 1994. A Review of High Iron Lag Geochemical sampling in the Paterson Province, WA, Research and Development Project R05874. Internal report 19895, CRA Exploration Pty. Limited (unpublished).

Broadbent, G.C, 1995. The Century Discovery, northwest Queensland - is exploration ever complete? The Australasian Institute of Mining and Metallurgy Publication Series 9/95, pp. 81-86.

Broadbent, G.C., Andrews, S.J. and Kelso, I.J., 2002. A decade of new ideas: geology and exploration history of the Century Zn-Pb-Ag Deposit, Northwestern Queensland, Australia. Society of Economic Geologists, Special Publication 9: 119-140.

Kelso, I., Briggs, T. and Basford, P., 2001. The Century Deposit - geological update. Australian Institute of Geoscientists Journal Paper, 2001-2003.

Ord, A., Hobbs, B.E., Zhang, Y., Broadbent, G.C., Brown, M., Willetts, G., Sorjonen-Ward, P., Walshe, J. L. and Zhao, C., 2002. Geodynamic modelling of the Century Deposit, Mt. Isa Province, Queensland. Australian Journal of Earth Sciences, 49: 1011-1039.

Waltho, A.E. and Andrews, S.J., 1993. The Century zinc-lead deposit, in northwest Queensland. In: Proceedings Centenary Conference. The Australasian Institute of Mining and Metallurgy, Melbourne. pp. 41-61.

SAMPLE MEDIA – SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Background (ppm)	Threshold (ppm)	Max anomaly (ppm)	Dispersion distance (m)
Saprolite	Zn	ICP/AAS	1	<800	800	11 500	0
(orebody O/C)	Pb	ICP/AAS	1	<300	300	22 100	0
	Ag	ICP-MS	0.1	<1	2	30	0
Manganiferous	Zn	ICP/AAS	1	<10 000	20 000	73 000	<25
ironstone	Pb	ICP/AAS	1	<2000	20 000	68 000	<25
(unconformity)	Ag	ICP-MS	0.1	<0.5	1	49	<25
	Cd	ICP-MS	0.1	<50	50	170	<25
Residual soil	Zn	ICP/AAS	1	<100	700	7200	<50
	Pb	ICP/AAS	1	<35	180	5300	<10
	Ag	ICP-MS	0.1	<1	1	14	<10
	Cd	ICP-MS	0.1	<1	7	34	<50
Ferruginous lag	Zn	ICP/AAS	1	<3000	5000	22 600	<10
	Pb	ICP/AAS	1	<1000	1800	132 000	<10
	Ag	ICP-MS	0.1	<1	2	31	<10
	Cd	ICP-MS	0.1	<8	15	160	<10
<180 µm	Zn	ICP/AAS	1	<20	135	700	<10 000
Stream	Pb	ICP/AAS	1	<20	45	75	<1500
sediments	Cd	ICP-MS	0.1	<0.5	0.5	0.8	<2000

ICP/AAS after digestion by aqua regia

ICP/MS after digestion with $HF-HClO_4-HCl-HNO_3$