NMNS#12965 before an atomic site became dominant in Zn (i.e. *c.* 20 wt.% ZnO). The distribution of Zn in these sonolite samples could not have been determined without the linear equation solutions.

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Lead oxychlorides at Elura, western NSW, Australia

SEVERAL different Pb oxychloride minerals are known to form under saline conditions, the most common being laurionite [Pb(OH)Cl] and mendipite [$Pb_3O_2Cl_2$]. Several others, penfieldite [$Pb_2Cl_3(OH)$] and fiedlerite [$Pb_3Cl_4(OH)_2$] are known mainly as marine corrosion products of ancient Pb objects or slags (Edwards *et al.*, 1992). The rare minerals, blixite [$Pb_2Cl(O,OH)_{2-x}$ where

TABLE 1. Ideal compositions of lead oxychlorides (wt.%)

Mineral Formula	Laurionite PbCl(OH)	Mendipite $Pb_3O_2Cl_2$	Blixite[1] $Pb_2Cl(O,OH)_{1.7}$	Damaraite $Pb_4O_3Cl_2$	Brilon mineral[2] $Pb_4O_3(Cl,SO_4)_2$
Pb	79.8	85.8	87.0	87.5	86.2
Cl	13.7	9.8	7.7	7.5	5.6
O	6.2	4.4	5.7	5.1	6.8
H	0.4	-	0.1	-	-
S	-	-	-	-	1.4

[1] actual composition determined by Gabrielson *et al.*, 1958
[2] actual composition determined by Rouse and Dunn, 1990

$x \sim 0.3$] and damaraite [$Pb_4O_3Cl_2$] have been recorded only at Langban, Sweden (Gabrielson *et al.*, 1958) and the Kombat Mine, Namibia (Criddle *et al.*, 1990) respectively. This note documents the presence of blixite and mendipite within the weathered profile at the Elura Zn–Pb–Ag deposit, 43 km NE of Cobar and 600km NE of Sydney, New South Wales.

Mineralization at Elura grades 5.8% Pb, 8.4% Zn and 130 g/t Ag and when fresh consists of assemblages of pyrite, sphalerite, pyrrhotite, galena and minor chalcopyrite in a gangue of siderite, quartz, muscovite and chlorite.

Weak weathering at about 130m depth results in the partial destruction of siderite and sphalerite with the intensity increasing until at 100 m only oxidized material is present (Taylor *et al.*, 1984). Supergene sulphides characterized by pyrite, galena, chalcocite, digenite and covellite occur at about 100 m as an interface between the oxidate zone and primary sulphide-bearing assemblages. Although this supergene sulphide zone is only a few metres thick, it exhibits gross zonation from Pb-rich (Pb = 30–50%) to Cu-rich assemblages (Cu > 35%) at its top. As well as the sulphides, anglesite, cerussite, blixite and mendipite are developed in this narrow zone.

Because of the relatively small size of the aggregates of crystals ($\sim 50 \times 20$ µm), the compositions of the Pb oxychlorides and their relationships to other lead minerals at Elura have been studied using an electron microprobe. Although chemical data readily differentiate most of the naturally occurring Pb oxychlorides, blixite [$Pb_2Cl(O,OH)_{2-x}$ and damaraite [$Pb_4O_3Cl_2$] have similar proportions of Pb and Cl (Table 1). Thus, whereas the Pb oxychloride with ~9% Cl at Elura is readily identified as mendipite (Table 2), lower Cl content material could be either blixite or damaraite. However, the presence of an X-ray diffraction peak at 2.93Å (the most intense peak for blixite, JCPDS 12-542) suggests the former. The blixite/mendipite association in the Mendip Hills, England (Symes and Embrey, 1977) is also consistent with a similar association at Elura (see below). Although some S occurs in the Pb oxychlorides at Elura (Table 2), this probably represents contamination from associated anglesite rather than incorporation of SO_4 into Cl sites as in blixite-type occurrences at Brilon, Germany (Rouse and Dunn, 1990). Lower S in mendipite replacing cerussite than in that replacing anglesite (Table 2) is consistent with this interpretation.

In Pb oxychloride-bearing samples from Elura, the following associations are present. Within sample 71072, mendipite replaces both cerussite and anglesite (Fig. 1) but because anglesite extensively replaces cerussite (Fig. 2), the mendi-

TABLE 2. Compositions of lead oxychlorides, Elura (wt.%)

	Mendipite		Blixite	
Sample No.	71072	71072	71073	71073
No. of analyses	6[1]	1[2]	4	4
Pb	83.43	83.52	85.80	85.19
Cl	9.24	8.29	8.84	6.20
Cu	0.23	0.18	0.13	0.11
Zn	0.01	0.03	0.04	0.06
Fe^{III}	1.07	0.92	0.50	0.19
S	0.28	0.10	0.61	0.22
O[3]	5.28	5.19	5.77	5.63
Total	99.54	98.23	101.69	97.60

[1] mendipite replacing anglesite
[2] mendipite replacing cerussite
[3] determined by stoichiometry

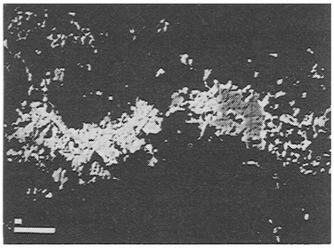

FIG. 1. Mendipite (dark grey) replacing anglesite (pale grey). Sample 71072. Scale bar ≡ 10 μm.

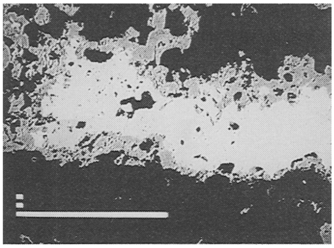

FIG. 2. Anglesite (grey) replacing cerussite (white). Sample 71072. Scale bar ≡ 100 μm.

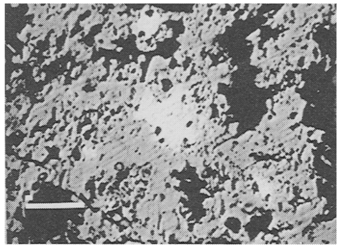

FIG. 3. Blixite/mendipite (white) replaced by anglesite (grey). Sample 71073. Scale bar ≡ 10 μm.

pite is probably all formed subsequent to anglesite. However in sample 71073 blixite or blixite/mendipite is replaced by anglesite (Fig. 3) with residual Cu sulphides often present in the Pb oxychlorides. Where blixite/mendipite masses are present, the blixite appears to replace mendipite.

Mendipite formation is restricted to temperatures above 29°C (Edwards *et al.*, 1992) but oxidation of sulphides could easily generate such a temperature at Elura. Therefore, the observed blixite replacement of mendipite could result from a decreasing temperature as well as decreased Cl or increased pH (Edwards *et al.*, 1992). The formation of mendipite also requires low CO_3^{2-} and SO_4^{2-} environments; hence the replacement of anglesite probably reflects an environment where Cl^- has been residually concentrated as CO_3^{2-} and SO_4^{2-} have been deposited as cerussite and anglesite. Anglesite replacement of mendipite implies exhaustion of Cl^- and a new supply of SO_4^{2-} being introduced. These features imply either two periods of anglesite formation at Elura or different processes occurrmg in different micro-environments within the supergene sulphide zone. Either case reflects the operation of complex weathering processes during supergene sulphide formation.

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