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South Australian type 3 chondrites. D. W. G. Sears,¹ J. D. Batchelor,¹ B. Mason,² E. R. D. Scott,³ R. N. Clayton⁴ and T. K. Mayeda.⁴
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A 50 km stretch of the South Australia/New South Wales border has yielded three especially interesting type 3 ordinary chondrite finds. Quinyambie, Starvation Lake and Moorabie (1–3). Another unusual type 3 ordinary chondrite, Willaroy (4, 5), was found in the same region, but probably too far away to be paired (210 km to the east), and its bulk composition is that of an H chondrite (6). Additionally, the chondrite, Boolka, was found within 1.6 km of Moorabie, but is not a type 3 chondrite.

Table 1 shows the data for Quinyambie, Starvation Lake and Moorabie. The silicates in Moorabie are highly reduced, while data for Starvation Lake fall in the equilibrated LL chondrite field and Quinyambie is intermediate between H and L. Bulk iron for all three is consistent with LL classification, although Moorabie lies in the region where L/LL chondrites overlap, and its higher metal content is reflected in a higher density (3.58 g/cm³ c/f 3.41 and 3.44 for Quinyambie and Starvation Lake). For all three the petrographic type determined by TL sensitivity is lower than that suggested by olivine heterogeneity and carbon content. At least one of these, Starvation Lake, is a fragmental breccia whose matrix is LL4 material of shock facies d–e (7); shock of this intensity

causes a factor of ≥ 10 decrease in TL sensitivity (8, 9). Natural TL data for all three are unusual and consistent with large terrestrial ages, if we use the natural TL vs. C-14 terrestrial age plot for Prairie State meteorites as a guide (10), these samples have terrestrial ages on the order of 10 000–20 000 y. The factor of 2 difference in natural TL between Moorabie and the others might reflect different terrestrial conditions or a large cosmogenic gradient in the preatmospheric mass. The closeness of the findsites for these meteorites, their similar petrographic type, natural and induced TL properties, and bulk compositions suggests that they are paired meteorites, especially for Quinyambie and Starvation Lake (see ref. [3]). The oxygen isotopic compositions of all three meteorites fall within the range of unequilibrated L and LL chondrites. Analyses of different pieces of the same meteorite show variations up to 0.5‰ in $\delta^{18}\text{O}$ due to internal heterogeneity. The isotopic data are compatible with a common origin for all three meteorites. However, the higher density, the unusual composition of its silicates and its lower natural TL make this conclusion less certain for Moorabie. References: (1) Clarke R. S. (ed.) (1975) *Meteoritics* **10**, 152. (2) Graham A. L. (ed.) (1985) *Meteoritics* **20**, 281. (3) Graham A. L. *et al.* (1985) *British Museum Catalogue of Meteorites*. (4) Chalmers R. and Mason B. (1977) *Rec. Aust. Mus.* **30**, 1. (5) Scott E. R. D. *et al.* (1981) *LPS* **16**, 749–750. (6) Sears D. W. G. and Weeks K. S. (1986) *GCA* **50**, 217. (7) Dodd R. T. and Jarosewich E. (1979) *EPSL* **44**, 335. (8) Sears D. W. G. *et al.* (1984) *GCA* **48**, 343. (9) Sears D. W. G. *et al.* (1982) *GCA* **46**, 2471. (10) Sears D. W. and Durrani S. A. (1979) *EPSL* **46**, 159. (11) Fitzgerald M. J. (1979) *Ph. D. thesis*, Univ. Adelaide. (12) Grady M. *et al.* (1989) *Meteoritics* **24**, 147.

TABLE 1. Data for three South Australian type 3 chondrites.

Meteorite	Fe (t) ⁴ (wt.%)	$\delta^{18}\text{O}$ (per mil)	$\delta^{17}\text{O}$	Fa (mole %)	Fs	C ⁴ (wt.%)	TL sens (Dhaj = 1)	T (m) (°C)	FWHM (°C)	nat TL (krad @ 250 °C)
Moorabie ¹	22.34	5.21	3.61	14 (5–20)	3–29	0.13	0.19 \pm 0.05	156 \pm 4	160 \pm 4	8.1 \pm 0.1
30°01'S, 141°04'E	22.68	5.56	3.80	σ = 2.4						
Type/class	L, LL	L, LL3		3.8		≥ 3.9	3.5	3.5–3.9	3.5–3.9	
Quinyambie ²	19.48	5.94	4.27	22 (5–35)	15–30	0.15/0.40	0.06 \pm 0.02	192 \pm 16	171 \pm 9	16.2 \pm 0.8
30°09'S, 140°59'E	19.0			σ = 7.7						
Type/class	LL	L, LL3		3.6		$\geq 3.9/3.3$	3.4	3.5–3.9	3.5–3.9	
Starvation Lake ³	20.14	5.47	3.81	29 (26–40)	12–24	0.05	0.14 \pm 0.06	176 \pm 6	161 \pm 9	14.4 \pm 0.4
30°28'S, 141°05'E	4.97	3.72		σ = 2.3						
Type/class	LL	L, LL3		3.9		≥ 3.9	3.5	3.5–3.9	3.5–3.9	

¹ Found by Lindsay Russell, manager of Moorabie station, 0.7 km north of the Boolka bore. The coordinates in ref. [3] refer to the homestead.

² Found by an Afghan stockman (possibly Barry Garrard) on Quinyambie station in South Australia, but on the New South Wales Border prior to 1968. He gave it to Lindsay Russell who gave it to Joe McLellan a mineral dealer in Broken Hill who sold it to the South Australian Museum. The coordinates are those of the Quinyambie homestead, exact findsite unknown.

³ The coordinates in ref. [3] refer to the lake rather than the findsite.

⁴ Elemental analyses by the Australian Mineral Laboratories and E. Jarosewich (unpublished, full analyses available on request) and by refs. (6, 11, 12).