Tasmania

Tasmanian Geological Survey
Record 1998/09

Diamonds in Tasmania

by R. S. Bottrill

Abstract

Diamonds occur in the Savage River–Donaldson River area of northwestern Tasmania, in placer deposits probably derived by reworking of high-level Tertiary sediments. The ultimate source of the diamonds in Tasmania remains enigmatic, but they may be subduction-related, and could have been carried to the surface in alkaline basaltic or lamprophyric dykes and breccia pipes. Exploration to date has been largely superficial, and typical indicator minerals may not be of great use.

Introduction and History

Diamonds have been known from Tasmania since 1894, when they were first found by L. Harvey, a prospector sluicing for gold, reportedly in Sunday Creek and Harveys Creek, both described as tributaries of the Savage River (Twelvetrees, 1918; fig. 1). More were subsequently found in the Donaldson River–Savage River area, including in Middletons Creek and possibly in Badger Creek (now Savage Creek).

The exact locations are uncertain. Harveys Creek was described as a tributary of Badger Creek by Twelvetrees, but was drawn as a tributary of Little Savage River by Reid (1921). Sunday Creek is generally taken to be Sabbath Creek (Russell, 1997), although this drains into the Donaldson rather than the Savage River. Twelvetrees (1918) noted newspaper reports of “a large number” of diamonds being found, but official records indicate only 16 or 18 were authenticated to 1910 (Petterd, 1910). Twelvetrees noted that the diamonds were of a character distinctive from other fields, so the occurrences were probably real.

One stone was also reported by Twelvetrees (1918) in ‘gem sand’ from the Hellyer River (exact location unknown).

Reid (1921) reported the presence of diamonds in thin sections of peridotite from the Heazlewood Ultramafic Complex at Bald Hill, northeast of Savage River. This reportedly occurred in olivine, within and predating chromite, but has not been confirmed by later studies.

There have been verbal reports of some diamonds being found in the Corinna district more recently (Hugh Nolan, pers. comm.), but there is no evidence that these have been verified.

Occurrence

The diamonds found in the Donaldson River–Savage River area were relatively small (up to 1/3 carat), slightly rounded octahedra, of near gem quality and with distinctive yellow apices. Only one is now known to exist and is lodged in the Tasmanian Museum and Art Gallery.

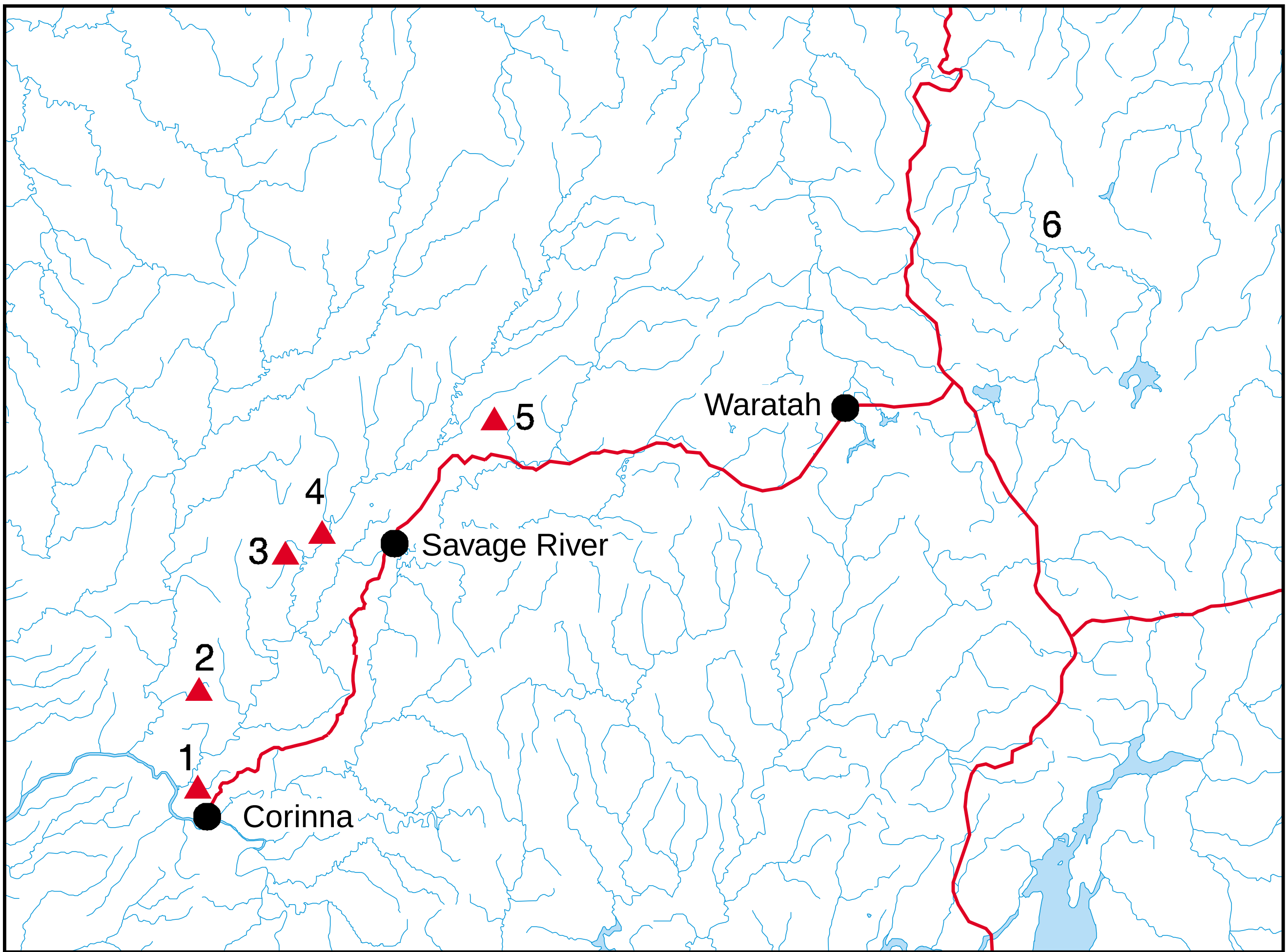
The diamonds were found in alluvial deposits with gold, chromite, ilmenite, spinel, osmiridium, cassiterite and topaz; most of these minerals are granite or ultrabasic-derived, and the source of diamonds is not known. No kimberlites, lamproites or other typical diamond source rocks are known in the area. The diamonds may have been reworked from high-level Tertiary alluvial deposits, which are common in the area, that were derived from the granite and ultrabasic areas further east.

Recent Exploration

Systematic exploration for diamonds in Tasmania has been relatively sparse to date.

The Mt Lyell Mining & Railway Company Ltd searched the Luina–Pieman area for various minerals in 1980/81, and specifically targeted diamonds (Hutton, 1980). The company collected stream-sediment samples in many catchments, including Middleton Creek, Sabbath Creek, Longback Creek, Nineteen Mile Creek, Harveys Creek and in the Browns Plains area. Chromite of possible kimberlitic affinity and garnets (possibly pyropes?), possible picro-ilmenites, and Cr-diopsides were reported. These were not followed up.

The Shell Company of Australasia Ltd explored an area near Adamsfield in southern Tasmania in 1981/82, which it considered prospective for diamonds (Ruxton, 1982). Pan concentrates showed garnets, pyroxenes, ilmenites, and zircons, all



REPORTED DIAMOND OCCURRENCES IN TASMANIA
(Approximate Locations)

1. Middleton Creek
2. Sunday Creek (Sabbath Creek)
3. Savage Creek (Badger Creek)
4. Harveys Creek
5. Bald Hill
6. Hellyer River

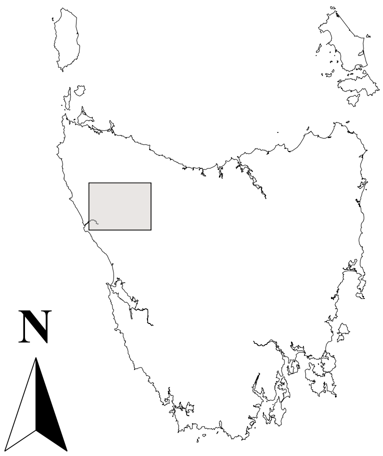


Figure 1

potential diamond indicators, but the area was not tested further.

Industrial & Mining Investigations Pty Ltd searched in the Savage River area for various minerals, including diamonds, between 1978 and 1985 (Penny *et al.*, 1984, Shannon, 1985, 1988). Stream-sediment samples were collected from the Little Savage River and Savage Creek and examined mineralogically. Some potential diamond indicator minerals were found, including Cr-spinel, but these were thought to be derived from the ultrabasic rocks and were not followed up. They considered that the origin of the diamonds was complicated by reworking of heavy minerals from Tertiary high-level sub-basaltic alluvial deposits in the area.

Petrecon Australia Pty Ltd held an Exploration Licence over the Arthur River area in northwest Tasmania in 1987/88. The company considered the area prospective for diamonds (Cromer *et al.*, 1988) with the Tertiary alluvial deposits having untested potential, but did not conduct any exploration.

Base Resources Ltd conducted more serious exploration in the Tyennan Element, in the Forth and Mersey River areas near Cradle Mountain, from 1984 to 1988 (Charchalis, 1988*a*, 1988*b*). The company considered that eroded material from above the Precambrian rocks in this Element could have been the source of the diamonds reported from the Corinna area and postulated that the lower parts of kimberlitic pipes may be present in this basement. The company specifically targeted diamonds in their stream sediment sampling for heavy minerals. These heavy minerals included garnets, pyroxenes, spinels, olivine, ilmenite and zircon. Some grains were examined in detail, including by electron microprobe analysis. A number of grains were of particular interest, including magnesian garnets (include pyrope with <12.3% MgO) and chromian pyroxenes (<1.2% Cr_2O_3); Charchalis, 1988*a*, 1988*b*). Most of these minerals were, however, considered to have various possible non-kimberlitic sources, e.g. basalt, Cambrian ultrabasic rocks, Precambrian metamorphic basement. No further work was done.

In 1997/98 Rio Tinto Exploration Pty Ltd took up some ground in the Donaldson River area, where there is a bulls-eye magnetic anomaly, but little work was done (McConachy, 1998). The anomaly was previously inconclusively ascribed by Geopeko Limited, who drilled the target, to be due to pyrrhotite-alteration of sediments (Pemberton, 1984).

Diamonds in Eastern Australia

Diamonds are widespread throughout New South Wales, being found in most of the principal Proterozoic, Palaeozoic and Mesozoic tectonic units (the Adelaide, Kanmantoo, Lachlan and New England Fold Belts, the Tamworth Zone and the Sydney–Bowen and Clarence–Morton Basins (Barron *et al.*, 1996; Birch and Barron, 1997). About two million diamonds have been found, mostly in Cainozoic alluvial deposits, but some have been found in situ in Cretaceous to Tertiary basic alkaline intrusive rocks (nepheline monchiquite, basanite, leucite basanite and leucite-nepheline basanite) (MacNevin, 1973; Barron *et al.*, 1996).

The main fields are around Copeton and Bingara in the New England district. The alluvial diamonds usually occur with zircons and corundum (sapphire), although diamonds typically occur in slightly older sediments than the sapphires (Lishmund and Oakes, 1983). The diamonds are unusual in chemistry, mineral inclusions and physical properties compared with kimberlitic and lamproitic diamonds, and the lack of abrasion and tribality of the occurrences indicates numerous small, local sources. They are commonly spatially associated with Tertiary basaltic pyroclastic rocks, diatreme breccias and dolerite, mostly of alkaline (basanitic) composition (Barron *et al.*, 1996). Most of these deposits appear to lack the characteristic indicator minerals of kimberlites and lamproites (Ross, 1986; Dawson, 1980), with the possible exception of pyrope garnets (MacNevin, 1973). Corundum may be a more useful indicator mineral, together with sodic garnets and pyroxenes (Barron *et al.*, 1996).

Diamonds and corundum in central Queensland are also thought to be sourced from spatially associated Tertiary basaltic pyroclastic rocks, and again diamonds may be somewhat earlier in age than the sapphires (Robertson and Sutherland, 1992).

Diamond occurrences are also widespread throughout Victoria, particularly near Beechworth in the northeast (Birch and Barron, 1997; Stone, 1976). Perhaps 200–300 stones have been found; the largest recorded was 8.2 carats, but most were less than 0.5 carat (Birch and Barron, 1997). Old reports suggest that there were probably many more but 'only an experienced eye would pick them' (Birch and Barron, 1997). They were all found in Cainozoic alluvial sediments (mostly gold and/or tin placers) with the sources being unknown. Sapphires are considered to be the best indicator minerals, so a basaltic source, as for deposits in NSW, is probable. Suggestions of a source in Permian glacial deposits cannot be discounted, but the patchy distribution favours small, local sources.

Genetic Model

Most diamonds worldwide are considered to be of two main types: P-diamonds of peridotitic affinity and of Archaean age; and E-diamonds of eclogitic affinity, formed during subduction at more than 1000 Ma and brought to the surface in kimberlites or lamproites (Barron *et al.*, 1996, Sutherland, 1996).

Taylor *et al.* (1990) suggested that the eastern Australian diamonds may be sourced from kimberlitic rocks in unexposed, delaminated Precambrian lithosphere underlying the diamond fields. There is no evidence for such lithosphere east of Broken Hill, and most of the lithosphere in eastern Australia is thin, mostly less than ~85 km thick (Barron *et al.*, 1996). Other problems with the model include the lack of kimberlitic indicator minerals, and the recent dating of a diamond from NSW at 300 Ma (Sutherland, 1996).

Barron *et al.* (1994, 1996) proposed a new model for diamond formation in New South Wales. This involves subduction of slabs of carbonaceous sediments down to the diamond-eclogite facies zone of the lithosphere, with temperature gradients lower than the surrounding lithosphere and arresting of the slabs within the diamond stability field. Subsequently diamonds formed from carbon therein, at depths as low as 75 km, rather than the normal 100–300 km for eclogitic or kimberlitic diamond (Sutherland, 1996). The diamonds may be captured and transported from the static slab as xenoliths or xenocrysts in various deep-sourced, rapidly emplaced magmas (alkaline basalt and lamprophyre). Sutherland (1996) noted that generation of the alkaline basalts, nephelinites and related rocks takes place at deeper levels. The rapid emplacement of these volatile magmas is needed to prevent resorption or recrystallisation of the diamonds to graphite. The diamonds are further concentrated by erosion of the breccia pipes and reworking into placer deposits.

Western Tasmania was a mobile zone during the Cambrian with a probable subduction zone, allowing for diamond formation. Such diamonds may have been 'sampled' by the lamprophyric intrusive rocks of Devonian and Cretaceous age, and/or the Tertiary alkali basalts and nephelinites. All these groups are widespread and locally common throughout Tasmania (Sutherland and Corbett, 1974; Ford, 1989, Sutherland, 1989; McClenaghan *et al.*, 1994), although no direct relationship with the diamond occurrences is known. There is a broad similarity between western Tasmania and the diamondiferous mobile zones surrounding the Kimberley Block in Western Australia, and in western NSW (Barron *et al.*, 1994).

The diamond potential of ultrabasic lamprophyres is not well evaluated (e.g. Rock *et al.*, 1992), but Helmstaedt (1993) noted that they are genetically related to kimberlites and some are diamondiferous, so they are worthy of further investigation. Lamprophyres in Tasmania are mostly calc-alkaline, but there may be potential for ultrabasic lamprophyres, which occur elsewhere in Australia and may contain some diamonds (Sutherland, 1996; Bottrill and Neef, 1998).

Discussion

Diamonds occur in the Savage River–Donaldson River area of northwest Tasmania, in placer deposits probably derived by reworking of Tertiary alluvial sediments. The ultimate source of the diamonds in Tasmania remains enigmatic, but by reference to similar occurrences in eastern Australia, it seems most probable that they are subduction-related and were probably carried to the surface in alkaline basaltic or lamprophyric dykes. These, unfortunately, are not always good sources of typical diamond indicator minerals, but magnetic surveys may be able to pinpoint breccia pipes.

Regions with mafic-poor arc volcanic rocks, blueschist and eclogite are considered favourable for subduction-diamond exploration (Barron *et al.*, 1996), and western and central Tasmania would fit this criteria.

The high-magnesian almandine, pyrope (Pyr_{44} Alm_{38} Gr_{16} Sps_1) and chromian diopside (<1.2% Cr_2O_3) found in the Cradle Mountain area (Charchalis, 1988a, 1988b) may well be of eclogitic or kimberlitic affinity (Barron *et al.*, 1996; Ross, 1986; Dawson, 1980; fig. 2). Some diopsides and pyropes (Pyr_{70-79} Alm_{17-19} Gr_{2-12}) in megacrysts and xenoliths in a basalt vent at Bow Hill, near Oatlands, have compositions similar to peridotitic minerals (Sutherland, 1984; fig. 2). High-Mg almandine and Cr-diopside were also reported from somewhere near Oatlands, and plot near the eclogite field (Ferguson and Sheraton, 1979; Brown, 1984; fig. 2). Unfortunately no Na analyses are available for any of these garnets, but these occurrences may all be worthy of follow-up diamond exploration.

It is recommended that all Tertiary basaltic breccia pipes throughout Tasmania be located and sampled for petrology, and tested for the presence of diamonds and indicator minerals, especially pyrope garnets and corundum.

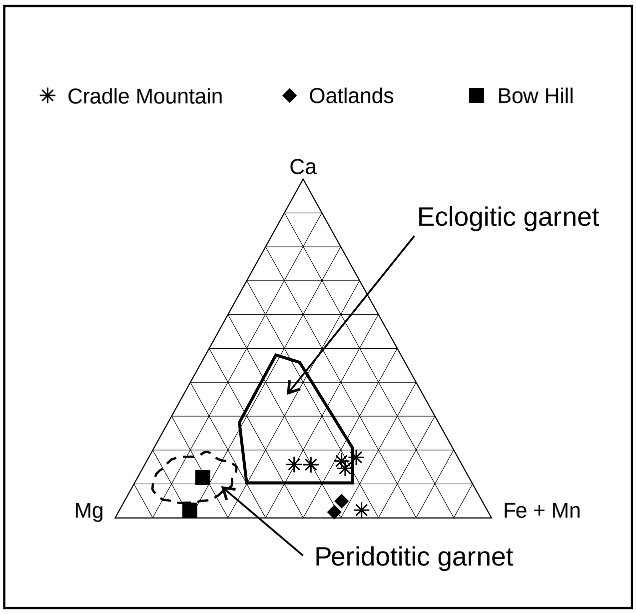


Figure 2

Compositions of Tasmanian garnets of possible high-pressure origin (from Brown, 1984; Sutherland,1984 and Charchalis, 1988a, b), with fields for diamond-associated garnets from Barron et al. *(1996).*

References

BARRON, L. M.; LISHMUND, S. R.; OAKES, G. M.; BARRON, B. J. 1994. Subduction diamonds in New South Wales; implications for exploration in eastern Australia. *Quarterly Notes Geological Survey of New South Wales* 94:1–23.

BARRON, L. M.; LISHMUND, S. R.; OAKES, G. M.; BARRON, B. J.; SUTHERLAND, F. L. 1996. Subduction model for the origin of some diamonds in the Phanerozoic of eastern New South Wales. *Australian Journal of Earth Sciences* 43:257–267.

BIRCH, W. D.; BARRON, L. 1997. Diamonds, in: BIRCH, W. D.; HENRY, D. A. (ed.). Gem minerals of Victoria. *Special Publication Mineralogical Society of Victori*a 4:16–33.

BOTTRILL, R. S.; NEEF, G. 1998. Mid-Devonian ultrabasic sill near White Cliffs, New South Wales. *Australian Journal of Earth Sciences* 45:93–96

BROWN, A. V. 1984. Reputed kimberlite occurrences: Oatlands area, *in:* FORSYTH, S. M. Geological Atlas 1:50 000 series. Sheet 68 (8313S). Oatlands. *Explanatory Report Geological Survey Tasmania* 181–182.

CHARCHALIS, N. 1988*a*. *Relinquishment Report Exploration Licence 29/83 Lemonthyme*. Base Resources Ltd [TCR 88-2765].

CHARCHALIS, N. 1988*b*. *Relinquishment Report Exploration Licence 48/82 Borradaile Plains*. Base Resources Ltd [TCR 88-2766].

CROMER, W. C.; DAVIDSON, J. K.; HOFTO, V. 1988. *Exploration Licence 24/87 Rapid River. Annual Report, Year 1 (September 1987 to September 1988)*. Petrecon Australia Pty Ltd [TCR 88-2854].

DAWSON, J. B. 1980. *Kimberlites and their xenoliths*. Springer-Verlag : Berlin.

FERGUSON, J.; SHERATON, J. W. 1979. Petrogenesis of kimberlitic rocks and associated xenoliths of southeastern Australia, *in:* BOYD, F. R.; MEYER, H. O. A. (ed.). Kimberlites, diatremes and diamonds: their geology, petrology and geochemistry. *Proceedings 2nd International Kimberlite Conference. American Geophysical Union, Washington* 1:140–160.

FORD, R. J. 1989. Cretaceous alkaline rocks, *in:* BURRETT, C. F.; MARTIN, E. L. (ed.). Geology and Mineral Resources of Tasmania. *Special Publication Geological Society of Australia* 15:381–383.

HELMSTAEDT, H. H. 1993. 'Primary' diamond deposits — what controls their size, grade and location? *in:* WHITING, B. H.; HODGSON, C. J.; MASON, R. (ed.). Giant ore deposits. *Special Publication Society of Economic Geologists* 2:13–80.

HUTTON, M. J. 1980. *Exploration Licence 26/78 (Tasmania) Pieman, precious stones. Relinquishment Report November 1980*. Mt Lyell Mining & Railway Co. Ltd [TCR 81-1517].

LISHMUND, S. R.; OAKES, G. M. 1983. Diamonds, sapphires and Cretaceous/Tertiary diatremes in New South Wales. *Quarterly Notes Geological Survey of New South Wales* 53:23–27.

MCCLENAGHAN, M. P.; SEYMOUR, D. B.; VILLA, I. M. 1994. Lamprophyre dyke suites from western Tasmania, their radiometric dating and the age of thrust faulting in the Point Hibbs area. *Australian Journal of Earth Sciences* 41:47–54.

MCCONACHY, T. F. 1998. *EL36/96 Pieman 1. Final Report incorporating work done for the period January to May 1988*. Rio Tinto Exploration Pty Ltd [TCR 98-4174].

MACNEVIN, A. A. 1973. Diamonds in New South Wales. *Mineral Resources Geological Survey NSW* 42.

PEMBERTON, J. 1984. *Progress Report on Longback EL 37/82 Tasmania*. Geopeko Ltd [TCR 84-2111].

PENNY, B. G.; SHANNON, C. H. C.; VANZINO, L. 1984. *Report on field investigations within Exploration Licence 4/61, West Coast, Tasmania*. Industrial & Mining Investigations Pty Ltd [TCR 84-2262].

PETTERD, W. F. 1910. *Catalogue of the minerals of Tasmania*. Department of Mines, Tasmania.

REID, A. M. 1921. Osmiridium in Tasmania. *Bulletin Geological Survey Tasmania* 32.

ROBERTSON, A. D. C.; SUTHERLAND, F. L. 1992. Possible origins and ages for sapphire and diamond from the Central Queensland gem fields. *Records of the Australian Museum* Supplement 15:45–54.

ROCK, N. M. S.; GRIFFIN, B. J.; EDGAR, A. D.; PAUL, D. K.; HERGT, J. M. 1992. A spectrum of potentially diamondiferous lamproites and minettes from the Jharia coalfield, eastern India. *Journal of Volcanology and Geothermal Research* 50:55–83.

ROSS, J. (ed.). 1986. Kimberlites and related rocks. Proceedings of the 4th International Kimberlite conference, Perth 1986. *Special Publication Geological Society of Australia* 14.

RUSSELL, S. A. J. 1997. *EL 36/96 Pieman 1. Annual Report for 11 month period ending 11 December 1997, Tasmania, Australia*. Rio Tinto Exploration Pty Ltd. [TCR 97-4089].

RUXTON, P. A. 1982. *EL 55/80 – Adamsfield, progress report on exploration during the period 18/5/81–1/7/82*. Shell Company of Australia Ltd [TCR 82-1821].

SHANNON, C. H. C. 1985. *Relinquishment Report on areas released from Exploration Licence 4/61, West Coast, Tasmani*a. Industrial & Mining Investigations Pty Ltd. [TCR 85-2332].

SHANNON, C. H. C. 1988. *Relinquishment Report on Exploration Licence 4/61, Savage River, Tasmania*. Savage Resources Ltd [TCR 88-2779].

STONE, D. M. 1976. Gemstones, *in:* DOUGLAS, J. G.; FERGUSON, J. A. (ed.). Geology of Victoria. *Special Publication Geological Society of Australia* 5:409–411.

SUTHERLAND, F. L. 1984. Cainozoic basalts, *in:* FORSYTH, S. M. Geological Atlas 1:50 000 series. Sheet 68 (8313S). Oatlands. *Explanatory Report Geological Survey Tasmania* 103–120.

SUTHERLAND, F. L. 1989. Tertiary volcanism, *in:* BURRETT, C. F.; MARTIN, E. L. (ed.). Geology and Mineral Resources of Tasmania. *Special Publication Geological Society of Australia* 15:383–398.

SUTHERLAND, F. L. 1996. Alkaline rocks and gemstones, Australia: a review and synthesis. *Australian Journal of Earth Sciences* 43:323–343.

SUTHERLAND, F. L.; CORBETT, E. B. 1974. The extent of Upper Mesozoic igneous activity in relation to lamprophyric intrusion in Tasmania. *Papers Proceedings Royal Society Tasmania* 107:175–190.

TAYLOR, W. R.; JAQUES, A. L.; RIDD, M. 1990. Nitrogen-defect aggregation characteristics of some Australasian diamonds: Time-temperature constraints on the source regions of pipe and alluvial diamonds. *American Mineralogist* 75:1290–1310.

TWELVETREES, W. H. 1918. Diamonds in Tasmania. *Circular Department of Mines Tasmania* 4.

[9 November 1998]