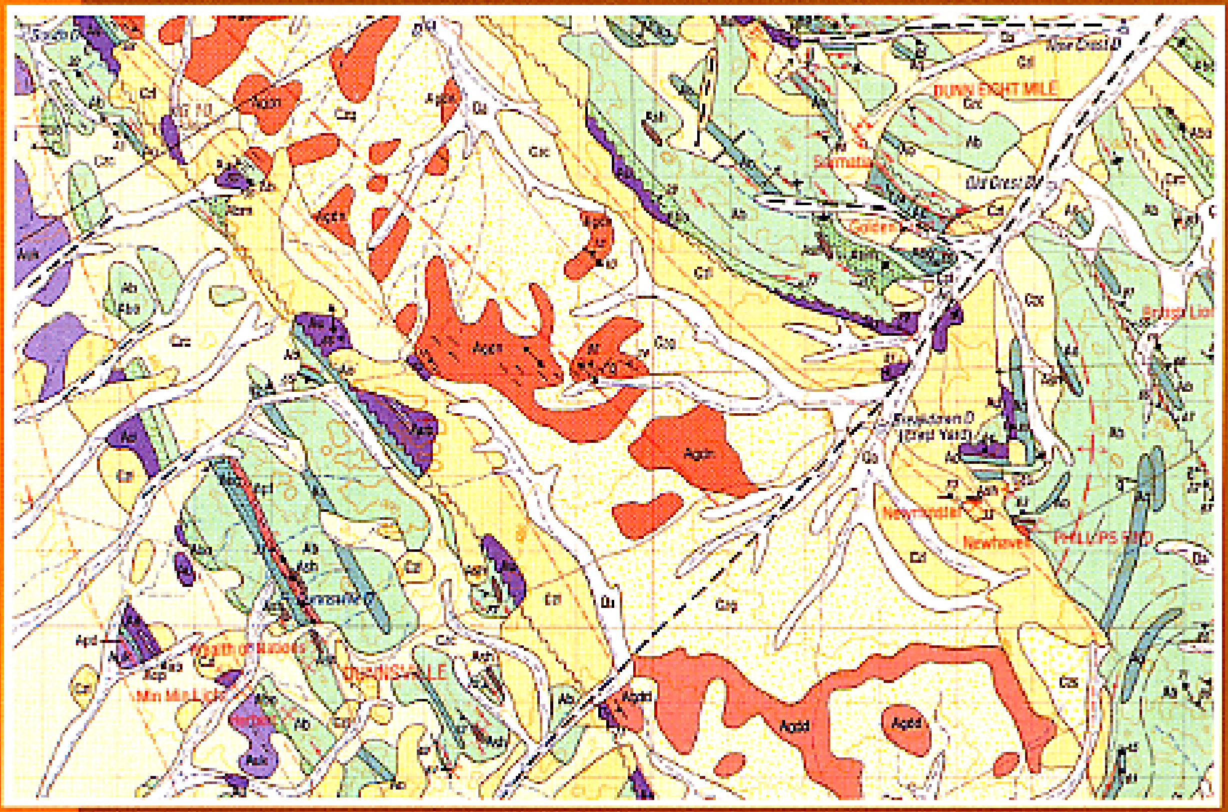
XPLANATORY NOTES

GEOLOGY OF THE DUNNSVILLE 1:100 000 SHEET

by C.P. SWAGER



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

DEPARTMENT OF MINERALS AND ENERGY

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

GEOLOGY OF THE DUNNSVILLE 1:100 000 SHEET

by
C. P. Swager

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Cover photograph:
A portion of the Dunnsville 1:100 000 geological sheet

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Introduction

The DUNNSVILLE 1:100 000 map (SH 51-9-3036) covers the central southern part of the KALGOORLIE 1:250 000 sheet (SH 51-9). The only previously published geological coverage of DUNNSVILLE is incorporated in the KALGOORLIE 1:250 000 sheet published in 1968, prior to the intensive nickel exploration efforts in the 1970s and the gold exploration boom in the 1980s.

DUNNSVILLE is one of a series of 1:100 000-scale geological maps that will cover the southern part of the Eastern Goldfields region of Western Australia. Mapping for DUNNSVILLE was carried out between March and December 1987 on 1:48 000-scale black-and-white aerial photographs.

Greenstone terrane was systematically mapped at photo scale along tracks and numerous foot traverses. Amount of exposure varies from reasonable to very little, and is commonly of low quality because of the extensive weathering and widespread drift cover.

The extensive granite terrane on the western part of DUNNSVILLE (Fig. 1) is less well exposed and access is poor. Mapping was concentrated along its eastern contact with the greenstone, and along a number of tracks on either side of the Kalgoorlie–Perth railway line. Mapping of the remaining granite outcrop is based on photo-interpretation.

Gibson (1908) gave short descriptions of the Dunn Eight Mile, Jaurdi, and Dunnsville gold mines, which were active in 1907. Montgomery (1910) described some of the mines at Dunnsville and Jaurdi, and Kriewaldt (1968) compiled the first edition KALGOORLIE 1:250 000 geological map, of which DUNNSVILLE is part. A number of exploration reports, including geological maps over selected parts of DUNNSVILLE, are held on open file by the Mines Department of Western Australia, and can be identified by means of the WAMEX system.

Physiography, access and Cainozoic geology

The physiography reflects to a large extent the underlying geology. The greenstone areas, with the exception of the steep Jaurdi Hills range, are characterized by open growth of eucalypts on low hills that attain a maximum elevation of 545 m. Granitoid areas, with the exception of several large inselbergs in the western belt, are lower and flatter. The flat area underlain by the Dunnsville Granodiorite and surrounded by greenstone hills resembles a wide, open amphitheatre. A prominent northerly trending, low-lying grassland area to the west of Dunnsville and Jaurdi dominates the drainage pattern. A relatively high ridge coincides approximately with the boundary between the eastern, greenstone-dominated terrane, and the western granitoid terrane. The area underlain by granitoid is mostly populated by stunted trees, but in spring has colourful wildflower displays. A detailed map of the regolith formations of DUNNSVILLE is in preparation (Gozzard, R., pers. comm. 1989).

The Great Eastern Highway and the Kalgoorlie–Perth railway line traverse the southeastern corner and southern half of DUNNSVILLE. Formed, but unsealed, roads include: the Coolgardie–Carbine–Davyhurst road in the northeastern corner; the Coolgardie–Jaurdi–Dunnsville road; and the Bullabulling–Stewart Siding road connecting the Great Eastern Highway with a maintenance track along the railway line. Numerous pastoral and former mining tracks allow access to the eastern half of DUNNSVILLE. The western half, underlain by granitoid, is less accessible. Sheep farming, centered on Mount Burgess, Carbine, and Credo Stations, is restricted to the eastern half of DUNNSVILLE.

Kriewaldt (1968) distinguished many Cainozoic deposits, but only seven are distinguished here.

Laterite (*Czl*) and deeply weathered rocks form extensive plateaus and lower areas of reworked products including pisolitic soils. Prominent laterite ridges occur along several granite–greenstone contacts, e.g. around the Dunnsville Granodiorite.

Colluvium (*Czc*) is reddish-brown, ferruginous, sandy clay and fine sand, with or without small pebbles, that has been derived by weathering, erosion, and transport of all rock types.

Quartzo-feldspathic sand (*Czg*) is a fine- to medium-grained quartz–feldspar sand, and has been derived by weathering and erosion of granites. Scattered, small pebbles of granitoid may be present.

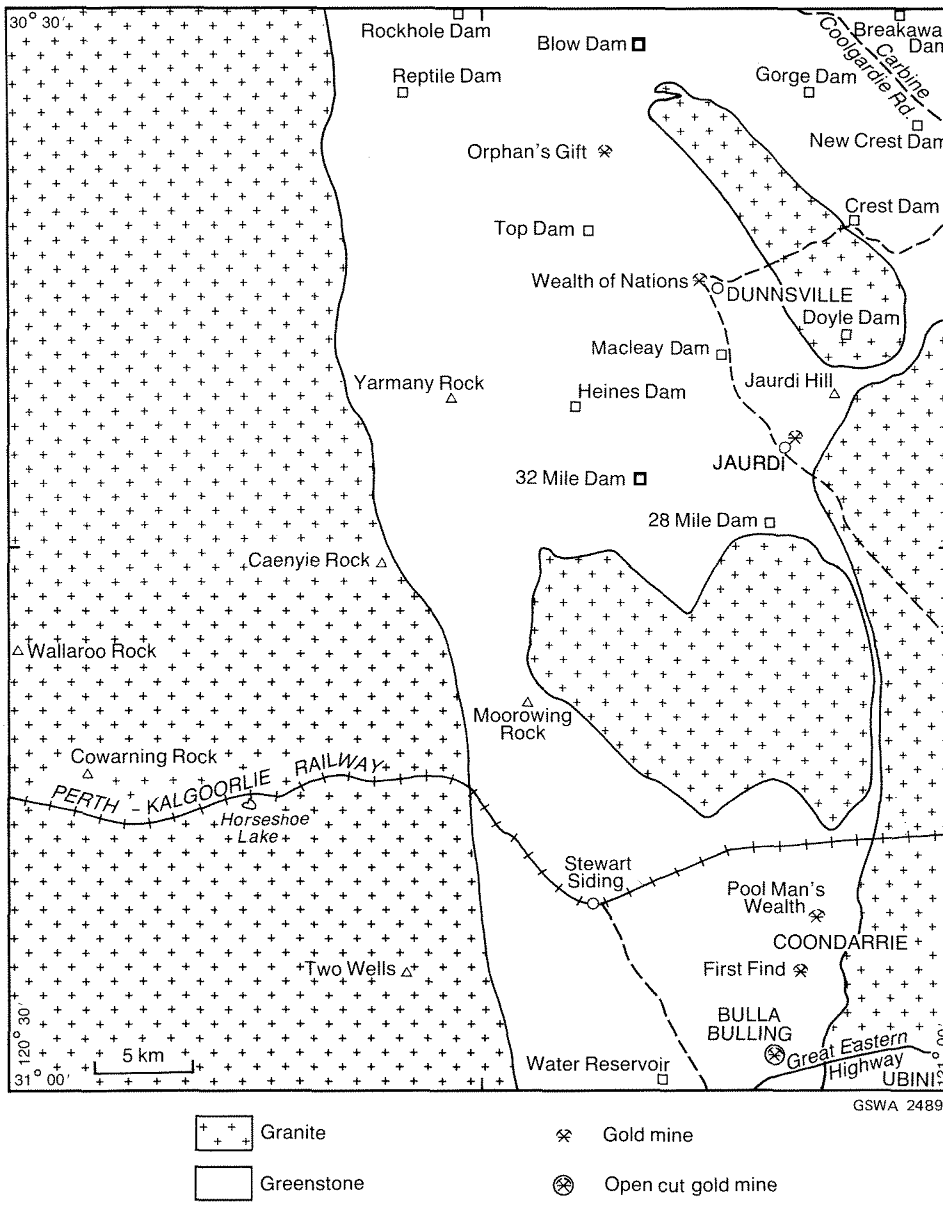

Figure 1. Localities and geological setting

Plains and low dunes of yellow sand (*Czs*) cover extensive areas in the eastern half of DUNNSVILLE. They are formed by sheets of sand of variable thickness, and contain a scattering of small pisoliths. At some localities, these sand sheets overlie harder, indurated sandstone, which may have formed during peneplanation or lateritization.

Salt lakes (playas) and clay pans (*Czts*) with interbedded clay and sand and evaporite minerals (gypsum, halite) are largely restricted to areas underlain by granitoid. They are commonly surrounded by stabilized dunes of sand, silt, and gypsum (*Cztd*) blown from the dried out playas.

Quaternary alluvium (*Qa*) in present-day drainage channels and floodplains consists of unconsolidated clay, silt, sand, and pebbles, depending on the local relief.

Regional geological setting and stratigraphy

Regional setting

DUNNSVILLE straddles the western margin of the Norseman–Wiluna greenstone belt in the Eastern Goldfields Province of the Archaean Yilgarn Block (Gee 1979). The Norseman–Wiluna Belt has been interpreted as a rift zone that developed within a more stable platform sequence. Gee (1979) refers to the continuous granitoid terrain to the west as the 'external granites' in contrast to the ovoid 'internal granites' within the supracrustal greenstones. The eastern limit of the external granite may coincide with the western boundary of the Norseman–Wiluna Belt. However, the location of this boundary is debatable (cf. maps in Gee et al. 1979, 1981; Hallberg

1986), and its interpretation will also depend on the mapping of DAVYHURST 1:100 000 sheet to the north.

DUNNSVILLE also lies within the 'dynamic' regional metamorphic domain of Binns et al. (1976). These dynamic domains are characterized by more pervasive deformation and higher metamorphic grades than the 'static' domains, and are restricted to the margins of the Norseman–Wiluna Belt.

Griffin (1990), in a major review of the geology of the Eastern Goldfields Province, divided all greenstone successions into a number of belts with internally consistent stratigraphies and structures. He placed the greenstones on DUNNSVILLE in the 'Coolgardie belt', which extends north into the "Mount Ida belt" and south into the 'Widgiemooltha belt'.

Stratigraphy

A proposed stratigraphy for DUNNSVILLE (Table 1) is dependent on the interpretation of the regional structure. A well-defined greenstone sequence is recognized in the eastern part of the sheet, and can be correlated with the stratigraphy around Coolgardie (Hunter,1993). However, the presence of several bodies of intrusive granitoid and the Kunanalling shear zone has complicated the correlation of greenstone units. Eastwards, areas of little outcrop make it difficult to establish a detailed stratigraphy.

The eastern (Dunnsville–Ubini area) greenstone sequence is separated from a central (Reptile Dam–Bullabulling area) sequence (Table 1; Fig. 2) by a prominent drainage system, both to the north and south of the Silt Dam Monzogranite. This poorly exposed central sequence is bounded to the west by the continuous mass of late-tectonic, external granitoid. The relationship between the eastern and central sequences is not clear, but it is possible that a major tectonic break exists between the two.

Dunnsville–Ubini

The lowermost unit of the sequence (Table 1) is basalt that is characterized by concordant dolerite or gabbro sills and thin, interflow, slate horizons. Numerous feldspar–quartz–biotite porphyry sills have intruded the basalt, in many cases along interflow slate and/or dolerite sills. This has resulted in a typical black slate–dolerite–porphyry association, which can be found throughout the area, and is of economic importance because it is associated with gold mineralization. Basaltic textures are preserved mainly in the north, but extensive recrystallization in most areas has produced amphibolite. Decussate, sheaf-like, and unoriented acicular amphiboles are quite typical in deformed and recrystallized basalt and dolerite. Locally, pseudo-igneous textures overprint earlier planar, tectonic fabrics.

The basalt unit is overlain by a thin ultramafic unit, which is commonly strongly deformed and consists of talc–carbonate and tremolite schists. Relict olivine spinifex and 'stringy beef' amphibole textures indicate precursor ultramafic komatiite and high-Mg (or komatiitic) basalt. Locally, layers or lenses of serpentinite suggest precursor peridotite or dunite.

This ultramafic unit is overlain by another basalt and ultramafic sequence that resembles the lower unit. The distribution of these lower and upper units is schematically illustrated in Figure 2. The repetition may be an original depositional feature, but can also be interpreted as an early (i.e. D_1) structural repetition. This implies that the upper contact of the lower ultramafic unit is a regional D_1 thrust fault.

Table 1. Stratigraphic sequences

Reptile Dam–Bullabulling (a)(b)	*Dunnsville–Ubini (b)*	*Coolgardie (Hunter, 1988)*
Sediment with interlayered amphibolites ultramafic lenses	Sediments and minor mafic volcanics	Black Flag Group
		Powder Sill
Feldspar-phyric basalt	Ultramafic komatiites incl. high-Mg basalts	Hampton Formation komatiites
Sediment minor intermediate volcanics minor amphibolite	Basalt minor ocellar basalt minor dolerite or gabbro sills	Burbanks Formation basalt + mafic intrusions
		Three Mile Hill Sill

(a) Internal structure of 'sequence' is not known
(b) There is an inferred tectonic contact between the Reptile Dam–Bullabulling sequence and the Dunnsville–Ubini sequence, and the stratigraphic relationship is unclear

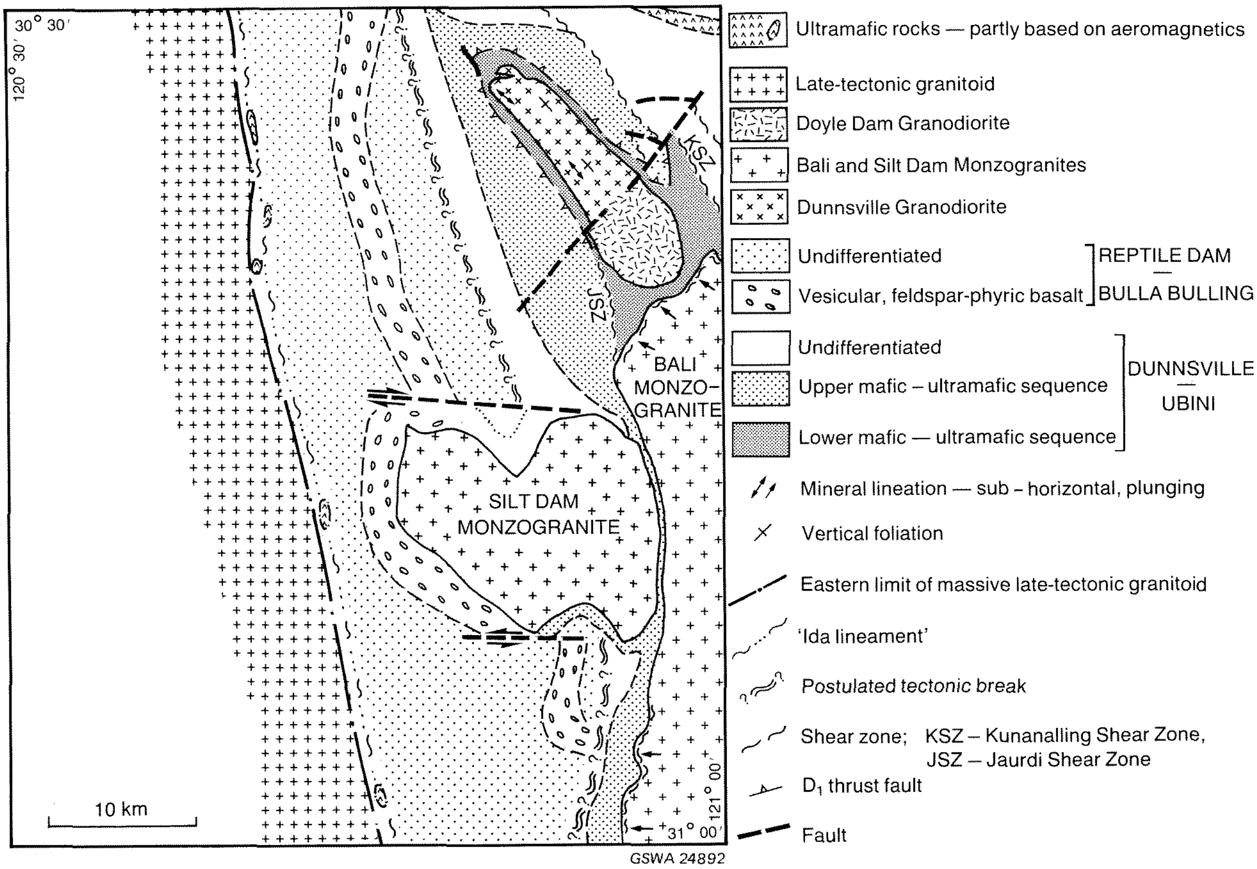

Figure 2. Geological sketch map of DUNNSVILLE highlighting major interpreted fault and shear zones

The upper ultramafic unit — which has been mapped as a single unit — also consists of various rock types, including komatiite with an olivine spinifex texture, serpentinized peridotite, and extensive high-Mg basalt with acicular ('stringy beef') amphibole, as well as, locally, ocellar, basalt.

Reptile Dam–Bullabulling

The ultramafic rocks are overlain to the west by a very poorly exposed basalt which may, or may not, be associated with a sediment or felsic volcaniclastic sequence in the north, and by clinopyroxene-bearing amphibolite in the south. As mentioned earlier, the relationship to the Dunnsville–Ubini sequence is not known. The possibilities include a normal stratigraphic succession, or separate successions juxtaposed by a major fault system that would underlie the north–south drainage system. There does appear to be a break between the two sequences such that as one proceeds southwards successive units of the Reptile Dam – Bullabulling sequence are cut out against the proposed fault system (Fig. 2). The Silt Dam Monzogranite cuts across the fault.

The younging directions and regional structures within the Reptile Dam – Bullabulling sequence are not known. The most easterly outcrops are sedimentary or felsic volcaniclastic rocks that are interlayered with basalt and dolerite. These are followed westwards by a distinctive, mappable unit of vesicular basalt that contains widespread fine- to medium-grained feldspar phenocrysts. Locally, andesite occurs between the feldspar-phyric basalt and the eastern sedimentary rocks. Further west, felsic volcaniclastic (quartz-phyric schist) and sedimentary rocks (slate and quartz–muscovite schist) are interlayered with lenses of amphibolitized basalt and dolerite. All these rocks are strongly foliated and have been metamorphosed under upper amphibolite facies conditions. The origin of the interlayering is unknown: it may be stratigraphic or tectonic. At the contact between this sequence and the external granitoid to the west, there are several isolated units of ultramafic schist and silicified peridotite (partly outcropping, partly inferred from aeromagnetics) present. Some of these ultramafic units are entirely surrounded by the late intrusive granitoid.

Northeastern area

Structural complexity, and lack of exposure in the northeast corner of DUNNSVILLE inhibit a confident interpretation of the stratigraphy. A prominent ultramafic komatiite unit is overlain to the northeast by felsic volcaniclastics that are interlayered with one or more thin layers of high-Mg basalt (now tremolite schist). To the southwest of the komatiite there is no outcrop, but shallow drilling indicates the presence of felsic porphyry, sedimentary rock and mafic, possibly intrusive, rock. Whether this sequence lies without tectonic breaks on top of the Dunnsville–Ubini sequence, southwest of the Coolgardie–Carbine road, is unknown, although a fault or shear zone may be present.

Granitoid

The greenstones are intruded by several phases of granitoid, including the pre- to syn-D_2 Dunnsville Granodiorite, the post-D_2 to syn-D_3 Bali and Silt Dam Monzogranites, the late syn- to post-D_3 Doyle Dam Granodiorite, as well as by the mass of late-tectonic granitoid in the western half of the area.

Petrography of the greenstones

Original rock nomenclature is used wherever original textures are preserved. However, all rocks are metamorphosed and their original mineralogy is entirely reconstituted. Regional deformation and metamorphism have resulted in widespread modification and obliteration of primary igneous and depositional textures. The resulting metamorphic textures will also be described, because in many cases they are characteristic for particular rock types.

Ultramafic rocks

Ultramafic komatiite (*Auk*), characterized by pseudomorphs of platy olivine spinifex textures in various sizes, is a major constituent of the ultramafic units around the Dunnsville dome, around the northern tip of the Bali Monzogranite, and to the southeast of Breakaway Dam. It now consists largely of tremolite and chlorite, or talc and chlorite, but contains variable amounts of carbonate and, locally, magnetite porphyroblasts.

Peridotite (*Aup*) is recognized by pseudomorphic orthocumulate olivine textures preserved as fine 'dust' rings within totally serpentinized equivalents and locally even within talc–carbonate domains (e.g. just west of Kintore). In the ultramafic units around the Dunnsville dome, peridotite occurs as finite lenses within the thicker, olivine spinifex-textured komatiite units; these lenses are interpreted as the B zones of komatiite flows. Locally, thin interflow black slate horizons were found.

Medium-grained cumulate textures can be recognized in the siliceous cap rock overlying peridotite at the western margin of the greenstone. This peridotite is largely surrounded by late-tectonic granitoid. No olivine spinifex textures were found, and it is not known whether the peridotite is intrusive or part of a (disrupted) komatiite flow. Furthermore, it occurs in a high-amphibolite facies domain, and the olivine textures may be metamorphic in origin.

Ultramafic schist (*Au*) occurs with all ultramafic units, and includes talc–chlorite schist, serpentinite, and tremolite schist. The latter is also derived from high-Mg basalt, and is described below in more detail.

High-Mg basalt

High-Mg, or komatiitic, basalt (*Abm*) is closely related to the ultramafic rock suite around the Dunnsville dome, and is considered part of the komatiitic flow sequences. It is particularly well exposed at the northern end of the dome. In the Breakaway Dam area, at least two high-Mg basalt units, now largely tremolite schist, overlie ultramafic komatiite to the northeast (just outside the map area), and appear interlayered with felsic volcani-clastic and sedimentary rocks.

The high-Mg basalt is characterized by acicular amphibole ('stringy beef') occurring as irregular sheaves — or without any preferred orientation — in a finer grained amphibole and plagioclase matrix. Locally, amphibole makes up more than 90% of the rock, and forms acicular crystals up to 10 cm long. The amphibole is supposedly pseudomorphic after pyroxene, of which no relics were found. The fine-grained amphibole in the matrix was probably produced during metamorphism of a devitrified glassy matrix or precursor fine pyroxene. The larger amphibole prisms and needles commonly contain very fine amphibole inclusions, presumably textures related to mineral transformations at greenschist–amphibolite transition facies conditions (Ahmat, A. T. , pers. comm. 1988). Locally, thin extension veins contain acicular to fibrous tremolite or actinolite which may have grown syntaxially on coarser matrix crystals.

Where high-Mg basalt is deformed, distinctive tremolite(–chlorite) schist results. The schist has a chlorite matrix in which long, irregular prisms of tremolite occur at small angles to the strong foliation outlined by the chlorite crystals. Newly grown, long, prismatic tremolite crystals crosscut this matrix at various angles to the foliation. In several instances, transitions can be observed from domains with well-preserved older foliation to domains where interlocking recrystallized tremolite dominates the texture. These tremolite schists form a large part of the ultramafic schist lens southwest of Reptile Dam.

Ocellar basalt

Ocellar basalt (*Abo*) occurs as thin units at various levels within the thick basalt (*Ab*) sequence, and also at one well-exposed area at the top of the ultramafic unit west of Macleay and Dunnsville Dams (Fig. 1). These mappable units can be followed for up to 8 km along strike, and then lens out.

The basalt, characterized by light-coloured, locally coalescing, ovoid ocelli, now consists of fine acicular actinolite or tremolite, with interstitial, partly sericitized and/or recrystallized plagioclase. Deformation has changed the rock into fine-grained tremolite (or actinolite)–plagioclase schist.

The ocellar textures are generally considered to be common in basalts at the lower end of the high-Mg basalt series.

Basalt

Basalt (*Ab*) is well exposed around the Dunnsville dome, and can be followed southwards from the Silt Dam Monzogranite. The basalt sequences are characterized by numerous concordant dolerite (*Ao*) and gabbro (*Aog*) layers or lenses, thin interflow black slates, and felsic porphyry intrusions. The basalt now consists largely of fine-grained acicular actinolite, recrystallized plagioclase in fine-grained polygonal granoblastic aggregates, and accessory phases including epidote, quartz, opaques, and leucoxene.

Narrow, strongly schistose domains separate more massive, fine-grained domains in which unoriented acicular hornblende can be recognized. The basalt has been strongly metamorphosed, and primary structures such as pillows and/or hyaloclastic textures have been found only locally in the northeastern part of DUNNSVILLE. In addition to the distinct dolerite and gabbro lenses, more diffuse, medium-grained domains with doleritic textures occur within the basalt units. Thin sections reveal that hornblende 'porphyroblasts' are commonly sheaves of acicular grains that have grown across an earlier hornblende–plagioclase fabric. This suggests that these domains were zones of metamorphic growth rather than separate intrusive sills.

It would appear that metamorphic reconstitution (?and intensity of deformation) increased from the Dunn Eight Mile area, to the Jaurdi and Bullabulling areas, where a basaltic origin can only be inferred for the amphibolite and hornblende–feldspar schist. In the latter areas, complex microstructures have developed with alternating bands of oriented, random, and sheaf-like acicular actinolite, that have enclosed an earlier planar fabric outlined by oriented grains of ilmenite and occasionally plagioclase. Such microstructures indicate that metamorphic recrystallization has largely obliterated earlier tectonic fabrics, and illustrate the complete textural reconstitution of the basalt.

Actinolite schist from a high-strain domain within the Kunanalling shear zone still shows a mylonitic fabric in which acicular prisms and very fine-grained recrystallized plagioclase define the foliation.

Vesicular, feldspar-phyric basalt

Vesicular, feldspar-phyric basalt (*Abp*) forms a distinct unit that extends across almost the entire map sheet. The unit cannot be traced south of the railway line, but can be followed northwards, closely 'wrapped around' the Silt Dam Monzogranite. The basalt is probably offset both north and south of the granites by accommodation faults related to granite emplacement. Further north, the unit is continuous from southwest of Heines Dam to Rockhole Dam. Several distinctly feldspar-phyric dolerite sills (*Aop*) can be mapped as concordant lenses.

The basalt is characterized in the field by numerous fine- to medium-grained, subhedral plagioclase phenocrysts and variable numbers of vesicles filled with quartz, epidote, or, locally, carbonate. The basalt now consists of fine actinolite, recrystallized plagioclase with small amounts of epidote, opaques, and leucoxene. The feldspar phenocrysts are extensively sericitized. Numerous, narrow zones of foliated hornblende schist or amphibolite, in which porphyroclasts of the feldspar phenocrysts are still recognizable, are present.

Plagioclase-phyric andesite

Andesite (*Aap*) is restricted to a small area just southeast of Heines Dam (Fig. 1) and some small exposures along strike to the north of the dam. The rock is strongly foliated and contains medium- to coarse-grained plagioclase phenocrysts, locally glomeroporphyritic, in a fine-grained recrystallized matrix of plagioclase and biotite. Folded and partly dissolved thin quartz veins illustrate the intense deformation.

Dolerite, gabbro, and feldspar-phyric dolerite

Dolerite (*Ao*) occurs as narrow sills and dykes throughout the basalt (*Ab*) sequence, and is characterized in hand specimen by a 'spotted' texture of medium-grained (1–4 mm) amphiboles in a fine-grained amphibole–plagioclase matrix. Some variations in size and composition can be observed across strike, but no unequivocal differentiation trend can be established. In many cases, relics of the igneous textures are preserved, but as described earlier, similar pseudo-igneous textures may result from porphyroblastic hornblende growth in strongly foliated basalt. Such hornblende commonly shows, in part, a radiating habit.

Locally, feldspar-phyric dolerite (*Aop*) occurs within the ultramafic unit west of Dunnsville. The rock contains stubby hornblende prisms with typical acicular overgrowths in a matrix of fine-grained recrystallized plagioclase, zoisite, and leucoxene or sphene, such that the medium-grained plagioclase phenocrysts (up to 5 mm) enclose many unoriented actinolite needles. Acicular overgrowths suggest retrograde (or polyphase) metamorphism (Ahmat, A. L., pers. comm. 1988).

Gabbro (*Aog*) differs from dolerite in exhibiting a more or less developed differentiated layering (used to infer younging directions). The gabbro sills vary in thickness from fifty to, possibly, several hundred metres; it may be that, locally, two sills are immediately adjacent. At the base of the sill, pyroxenite or pyroxenitic gabbro is characterized by medium- to, locally, coarse-grained (3–8 mm) amphiboles after pyroxene, and there is only a small amount of interstitial fine-grained amphibole and plagioclase matrix. Upwards from the base, the phenocryst to matrix ratio, as well as the phenocryst size, decreases, and the gabbro becomes more leucocratic. Locally small quartz and quartz–feldspar patches ('granophyre') are found towards the top. In one example 2 km south of Dunn Eight Mile, a massive medium-grained pyroxenitic layer about 3 m thick (possibly amphibolitized bronzite) is interpreted as the base of a relatively thick, uniform gabbro.

In most cases the differentiation trends are weaker than those of the major differentiated sills on BARDOC (Witt 1987).

Textural adjustments did occur in undeformed gabbro, where, for example, acicular terminations on short prismatic amphiboles after pyroxene are interpreted as metamorphic overgrowths. Recrystallization, sericitization, and epidotization of feldspar are also widespread.

Both gabbro and dolerite occur mostly as concordant sills, and in many cases along thin interflow slates. These horizons are characterized by intense deformation, and the intrusion of felsic porphyry. The strong deformation and accompanying recrystallization have resulted in hornblende schists with quite distinctive textures of medium-grained, acicular actinolitic hornblende lying within, or at small angles to, the foliation plane. They contrast with the short prismatic amphiboles which pseudomorphed the precursor pyroxenes. The acicular actinolite is unoriented: it occurs in sheaves or rosettes, and is commonly curved. In thin section, it is seen to have grown across the regional foliation at small angles.

At Ubini, gabbro has been transformed to amphibolite with recrystallized, polygonal granoblastic amphibole and plagioclase bounded by oriented hornblende prisms. Locally, a metamorphic layering is defined by bands rich in epidote and zoisite.

Feldspar-phyric dolerite (*Aop*) forms thin (20–50 m) concordant sills in the vesicular feldspar-phyric basalt (*Abp*). The feldspar phenocrysts vary in size (4–8 mm), and are generally slightly larger than medium-grained amphibole pseudomorphs of pyroxene phenocrysts. Extensive metamorphic reconstitution has occurred.

Amphibolite

Amphibolite (*Ama*) is characterized by a well-developed metamorphic foliation and/or layering. In most cases it is impossible to infer precursors, although possible basaltic textures are locally present (e.g. ovoid quartz aggregates suggesting amygdales). Flat-lying to shallow-dipping amphibolite is widely exposed between the Bullabulling water reservoir and the railway line, but the only relatively fresh exposures are in the pipeline south of the reservoir. They consist of medium-grained prismatic amphibole and polygonal granoblastic plagioclase with a weak, preferred orientation. Layering is defined by variation in the ratio of amphibole to plagioclase.

West of Reptile Dam, layers of fine-grained leucocratic amphibole-bearing (15–25%) quartz–plagioclase schist, are interleaved with the amphibolite.

Clinopyroxene–plagioclase layers are found at several localities: in old workings (First Find) directly west of the ultramafics south of the railway, in amphibolite east of the Bullabulling–Stewart Siding road, and west of Reptile Dam. The medium- to coarse-grained clinopyroxene is typically poikilitic, encloses rounded plagioclase, and is of metamorphic origin. Drillcore from the northwesternmost ultramafic schist shows clinopyroxene-bearing schist interlayered with tremolite schist that was derived from high-Mg basalt.

Pelitic and felsic volcaniclastic rocks

Interbedded pelitic sedimentary and felsic volcaniclastic rocks have been mapped as a single, wide zone (*Asf*) in the Reptile Dam – Bullabulling greenstone because distinction between rock types is generally difficult in the poorly exposed and highly weathered terrain. At several localities, the interlayering of fine-grained pelitic slate and schist with schistose volcanic or volcaniclastic rocks can be observed, e.g. on a small scale in the railway cutting west of Stewart Siding, and, on a larger scale, 4 km south of that exposure.

The pelitic sedimentary rocks are most commonly represented by grey to black slate and schist. They are mostly very strongly weathered, and locally occur as low, lateritized plateaus (e.g. Yarmany Rock), where the regional vertical foliation is the only structure observed. Relatively fresh exposures are present directly west of Orphan's Gift Mine. The fine-grained schist, locally with more siliceous layers, shows graded bedding, overprinted by the regional foliation. Evidence for small-scale folding suggests quite extensive structural thickening. Elsewhere, pelitic schist has recrystallized into fine- to medium-grained quartz–muscovite–biotite schist. Andalusite, locally with well-developed hour-glass inclusion textures, is a common constituent of the schists, and occurs as fine- to very coarse-grained prisms, e.g. 2 km west of Reptile Dam. At the same locality, fine-grained euhedral garnet is present in biotite schist.

Quartzo-feldspathic schist, presumably of volcaniclastic origin, is generally very strongly weathered.

Carbonaceous, black to grey slate and schist (*Ash*) occur as thin (1–3 m) interflow layers and lenses within basalt (*Ab*) and komatiitic units (*Auk*). They are fine grained, locally show graded bedding, and contain either finely disseminated grains of pyrite or coarse nodules. These interflow beds may have acted as the localizing structures for the emplacement of dolerite, gabbro, and felsic porphyry sills.

Felsic volcanic and volcaniclastic sedimentary rock

A thin layer of felsic volcaniclastic rock (*Af*), with subordinate black slate, was observed at one locality (2.5 km east-southeast of Gorge Dam) within basalt (*Ab*). Some specimens from mine dumps suggest agglomeratic textures. In the northeast corner of DUNNSVILLE, a thicker package of well-layered, quartzo-feldspathic volcaniclastic and possible crystal vitric tuff overlies talc–chlorite schist (*Au*) derived from ultramafic komatiite, and is interlayered with at least two thin units of tremolite schist, derived from high-Mg basalt. These felsic rocks are strongly foliated, and show plagioclase and quartz phenocrysts in a fine-grained recrystallized matrix.

Plagioclase phenocrysts are extensively sericitized and locally replaced by biotite. Quartz crystals can still be recognized by their subhedral outlines, but have been recrystallized into granoblastic aggregates. Biotite also occurs as single grains and elongate aggregates parallel to the regional foliation. Isolated, small, bluish-green pleochroic amphibole grains, in combination with biotite, suggest intermediate compositions.

Quartz-phyric felsic schist

Felsic schist (*Afq*) is poorly exposed southeast and northwest of Stewart Siding. It is well foliated, and contains 20–30% small (1–3 mm), rounded quartz eyes. The schist was possibly derived from felsic tuffaceous rocks with partly resorbed quartz phenocrysts.

Porphyry

Intrusive porphyry is common, particularly in basalt (*Ab*) and, to a lesser extent, in ultramafic units (*Auk, Abm, Au*), and in the sedimentary or felsic volcaniclastic–basalt sequence (*Asf* and *Abp*), but it appears to be rare or absent to the west of the major feldspar-phyric basalt unit (*Abp*). Almost all of the porphyry intrusions occur as narrow stratabound sills, in many cases adjacent to thin interflow slate and/or basalt–dolerite (or gabbro) sill contacts. Only a few crosscutting dykes were encountered. The porphyry sills and dykes vary in thickness from 1–50 m, and in strike length from several tens of metres to several kilometres. Their intrusive nature is inferred from the few crosscutting dyke occurrences, as well as from observations on samples obtained from mine dumps. These suggest that porphyry has intruded both basalt and dolerite or gabbro, because small greenstone fragments are commonly enclosed in the porphyry. Porphyry appears to have been preferentially intruded along existing planes of weakness.

Felsic porphyry (*Apf*) is particularly common in basalt (*Ab*). It is characterized by medium-grained (1–5 mm) plagioclase and/or quartz phenocrysts in a fine-grained, commonly foliated, quartz–feldspar–biotite (–muscovite) matrix. Locally, medium-grained biotite aggregates are prominent. The association with interflow slate and dolerite or gabbro sills is of economic importance, because many small gold workings occur along these contacts. Virtually everywhere, these contacts were sites of more intense deformation that resulted in strongly foliated fabrics.

Albite-rich porphyry (*Apa*) is restricted to ultramafic host rocks. It contains up to 70% medium-grained, commonly zoned, plagioclase, interstitial fine-grained prismatic to acicular amphibole (15%), and fine quartz (15%). The plagioclase is partly recrystallized into finer grained aggregates.

Dacitic porphyry (*Apd*) was encountered at two localities only: in ultramafic rocks 1 km west of Dunnsville, and within volcaniclastic sediments 1 km due north of Top Dam. Both occurrences are strongly foliated and consist of recrystallized feldspar laths, though, locally, subgrain aggregates outline medium-grained precursors. At the occurrence west of Dunnsville, plagioclase makes up 75% of the rock, while acicular amphibole (gedrite), euhedral sphene, scattered quartz, and fine opaques make up the remainder. North of Top Dam, prismatic hornblende and late metamorphic acicular amphibole (cummingtonite–grunerite), as well as fine-grained biotite, are the mafic constituents of the porphyry.

Granitic porphyry (*Apg*) is possibly better described as microgranite. It forms dykes or plugs, and may represent small offshoots from larger nearby plutons. These intrusions are particularly common along the contact with the western granitoid belt, where they crosscut the greenstones without any apparent later deformation.

Pegmatite

Pegmatite dykes with a simple quartz–feldspar–muscovite mineralogy, are common along the western belt of late-tectonic granitoids. Furthermore, pegmatites are common in basalt (*Ab*) and ultramafic rocks (*Auk, Au*) to the south of the railway line. Where hosted by ultramafic rock, the pegmatite dykes contain lepidolite and amblygonite, small amounts of which have been mined.

Granitoids

Granitoids on DUNNSVILLE can be distinguished on structural and petrographic characteristics. Structural criteria include granitoid–greenstone contact relationships and geometrical interference patterns between regional structures in greenstones and granitoid plutons.

Dunnsville Granodiorite

The Dunnsville Granodiorite (*Agdn*) in the northeastern part of the map has an areal extent of approximately 35 km^2 (Fig. 2), and is named after the former township of Dunnsville. Fresh exposures are found in the northern part of the outcrop, whereas the remainder is very strongly weathered. The main constituents are plagioclase (40–45%), K-feldspar (10–15%), quartz (40–45%), and biotite and hornblende (5%); accessory minerals include sphene, epidote, apatite, and zircon.

Medium- to coarse-grained plagioclase (1–8 mm) displays oscillatory zoning, and locally encloses biotite (–sphene–epidote) aggregates. Recrystallization of plagioclase and quartz has resulted in fine- and medium-grained polygonal granoblastic aggregates respectively. Fine K-feldspar may also represent a product of recrystallization of larger precursor grains. Some small myrmekite grains are present.

Aggregates of fine- to medium-grained biotite, in which the individual plates are unoriented, enclose zircon with metamict haloes, and are associated with trails of fine, rounded sphene. Medium-grained hornblende is often poikilitic with rounded quartz and/or feldspar inclusions, and mostly occurs with biotite in distinct aggregates.

Medium-grained subhedral sphene is associated with hornblende and biotite. Fine-grained apatite is present as short prismatic crystals.

The granodiorite is exposed in the core of a regional F_2 anticline, and contains a regional, vertical north-northwesterly trending foliation that is parallel to the axial plane of the anticline (Fig. 2). This S_2 foliation shows more intense development in widely spaced zones, characterized by a subhorizontal mineral lineation outlined by elongate quartz aggregates.

Granodiorite–greenstone contacts are zones of hornblende schist and granite gneiss — the result of intense ductile deformation. Around the northern closure of the granodiorite dome, a well-developed mineral lineation shows horizontal to shallow plunges. The contact appears parallel with the greenstone layering, but on a larger scale is clearly crosscutting. A sliver of basalt (*Ab*) is preserved around the northwest side of the dome, but is cut out further southwards. Furthermore, in the northern hinge of the dome, the granodiorite is interleaved with greenstones (Fig. 2).

The preferred interpretation for development of the dome, is that the Dunnsville Granodiorite was intruded as a sheet-like pluton, possibly as early as D_1 or as late as early D_2. Subsequently upright F_2 folding resulted in the domal structure which was partly controlled by the ductility contrast between the competent granite and incompetent greenstones. A similar model was proposed for the Lawlers area by Platt et al. (1978). Alternatively, the granodiorite may have intruded as a syn-D_2 diapir, that was subsequently deformed into a more ellipsoidal shape.

Several mafic enclaves were found with a strongly developed foliation parallel to that in granodiorite. Mineral constituents are the same as for the granodiorite, but with appreciably more biotite and hornblende. The strong foliation is defined by biotite, recrystallized feldspar, and quartz; hornblende has grown across and along this foliation.

Bali and Silt Dam Monzogranites

The Bali Monzogranite (*Agbl*) occupies an area of approximately 400 km^2 on both DUNNSVILLE and KALGOORLIE (Hunter 1988; 1993) and is named after the locality along the Great Eastern Highway on the latter sheet (Figs. 2, 3). It is a K-feldspar (3–5 cm) porphyritic biotite monzogranite, and possibly consists of more than one pluton. Its contact with the greenstone shows a wide (100 m) zone of intense ductile deformation that has resulted in granitoid gneisses and fine-grained quartz–feldspar schists with feldspar porphyroclasts. Extensive recrystallization resulted in fine-grained polygonal granoblastic domains, though, locally, quartz ribbons still indicate the mylonitic origin of the schist. Muscovite occurs as a second mica in these gneisses, subordinate to biotite. Locally mica-free, garnet-bearing quartz–feldspar schists suggest aplitic phases along the contact (Bettenay 1977).

Very weak foliations occur away from the contacts, and are mainly defined by trails of biotite.

The Silt Dam Monzogranite (*Agst*) is very poorly exposed; it is named after a dam in the western half of the area underlain by the unit. It is partly outlined by exposures of feldspar-phyric basalt (*Abp*). Aeromagnetics clearly suggest two separate plutons with slightly different magnetic characteristics, each of which has an area of approximately 100 km^2. Each intrusion is a biotite monzogranite; K-feldspar shows the largest grain size without, however, forming a clear porphyritic texture. K-feldspar encloses all other phases including fine-grained myrmekite. Plagioclase shows locally well-developed zoning. Quartz is recrystallized into equant polygonal aggregates. Fine-grained, regularly distributed biotite is the only mafic phase. Other phyllosilicates include secondary muscovite and chlorite.

The foliation in the outer zone of the Bali Monzogranite is everywhere parallel to the granite–greenstone contact. Steep down-dip mineral lineations (Fig. 3) are common in the granitoid gneisses of the Bali Monzogranite (Hunter, 1993), but are less intense in strongly recrystallized schists. Sense of shear indicators, including S-C fabrics and porphyroclast–foliation relationships, suggest normal fault movement, i.e. granitoid up – greenstone down. On a larger scale, both the Bali and Silt Dam Monzogranites have cut across and pushed aside the greenstone layering and regional F_2 fold traces, as seen around the northern part of the Bali Monzogranite. The Silt Dam Monzogranite has pushed aside the vesicular, feldspar-phyric basalt (*Abp*). Approximately east-striking accommodation faults can be inferred, both to the north and south of the Silt Dam Monzogranite (Fig. 2).

This combination of geometrical relationships suggests that these bodies of monzogranite intruded as diapirs (magmatic or possibly solid state) after F_2 folding. The Bali Monzogranite is bounded to the northeast by the Kunanalling shear zone (Fig. 3), which shows little or no deviation; this suggests that the diapirs do not postdate the D_3 shear zone. However, along the granitoid–shear zone contact the granitoids still show the down-dip mineral lineation, rather than a shallow-plunging lineation. This indicates that the diapir may have been partly emplaced along the shear zone after the major horizontal displacement. Thus, the upper time limit of diapiric intrusion is poorly constrained, but may be late during D_3.

Doyle Dam Granodiorite

The Doyle Dam Granodiorite (*Agdd*) occurs directly south of the Dunnsville Granodiorite, has an area of approximately 30 km^2, and is named after the dam near its centre (Fig. 2). Some good exposures just north of the dam show a composition very similar to that of the domal Dunnsville Granodiorite. However, the Doyle Dam Granodiorite is little deformed to massive, locally with a weak magmatic layering, and shows entirely different geometrical relationships with the greenstone sequence. It appears in direct, but ?faulted contact with the southern end of the Dunnsville Granodiorite.

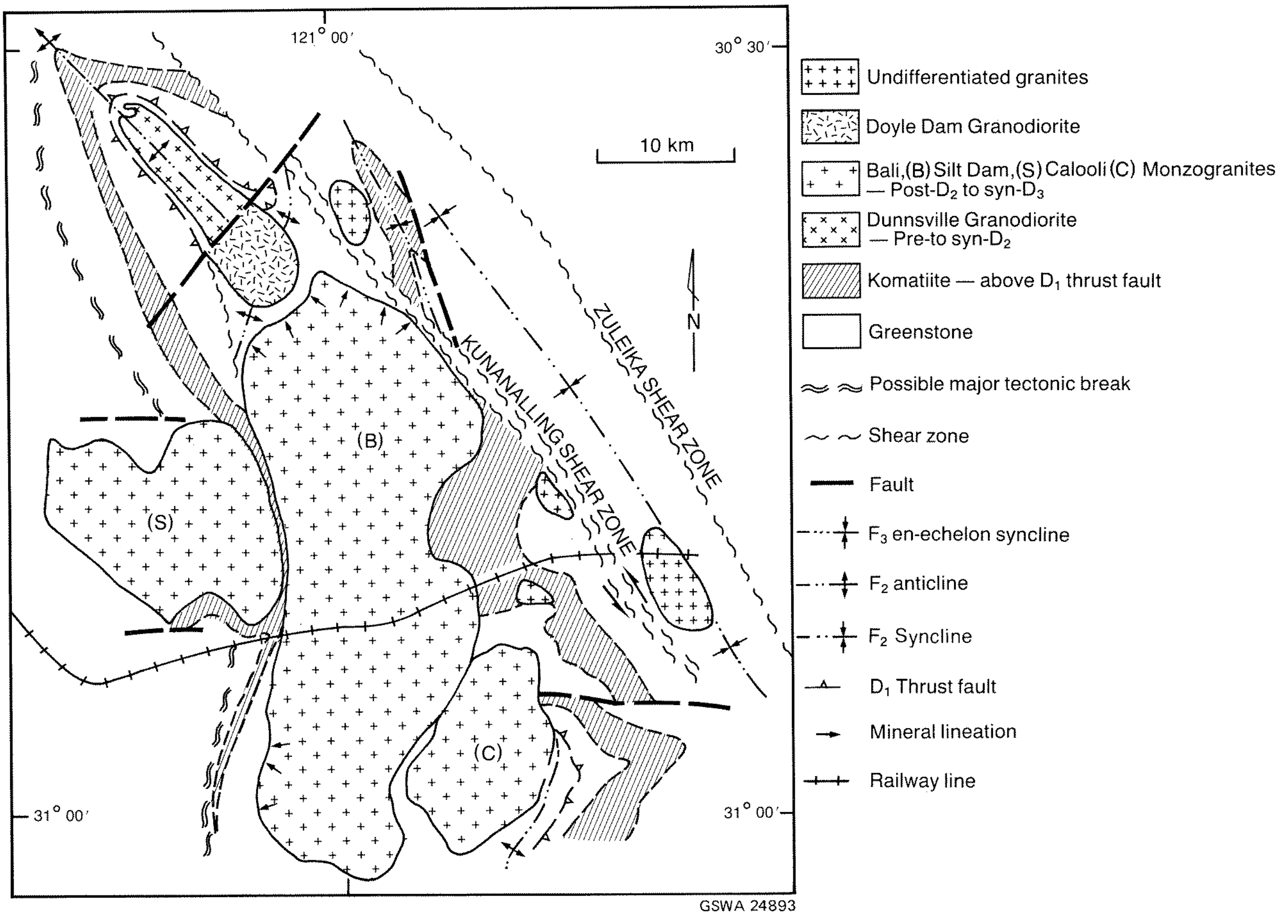

Figure 3. Sketch map showing continuation of major fault and shear-zone structures between DUNNSVILLE and KALGOORLIE map sheets.

Medium- to coarse-grained plagioclase (45%) shows oscillatory zoning, inclusions of biotite and epidote, as well as fine, stubby apatite prisms. K-feldspar (<10%) is fine- to medium-grained, and only occurs interstitially to plagioclase and quartz. Large aggregates of fine- to medium-grained quartz (35%) probably reflect coarser precursor grains. Medium-grained green and brown biotite, and bluish-green hornblende (6–10%) form distinctive aggregates with associated fine- to medium-grained euhedral sphene and widespread epidote. Acicular grains of exsolved rutile are present in some biotite. The mafic minerals also occur as finer grains scattered through the rock.

The Doyle Dam Granodiorite was emplaced in an entirely different manner from the Dunnsville Granodiorite. It has crosscut and displaced the southern extension of the regional F_2 anticline, which was already deflected by the post-D_2 to syn-D_3 Bali Monzogranite. A major east-northeasterly trending fault developed between the two granodiorites, and can be traced laterally into the greenstones. Most displacement probably took place to the east of the granodiorite, where at least partly sinistral movement can be inferred; the amount of vertical movement, if any, is unknown. The isolated fold with a west-northwesterly trending axial surface, directly southeast of Crest Dam, is also attributed to shortening as a result of the granodiorite emplacement. The major accommodation fault may possibly have displaced the Kunanalling shear zone. Several other faults directly northwest of this major fault have chopped up the greenstones, and similarly may be accommodation features. The overall geometry suggests that the Doyle Dam Granodiorite was emplaced forcefully, offsetting D_2 and possibly D_3 structures. Figure 4 shows schematically the proposed sequence of granitoid emplacement and its effects on the structures in the greenstone sequence.

Late-tectonic granites

The entire western part of DUNNSVILLE is underlain by a continuous, northerly trending belt of granitoid (*Agl*) that continues north and south of the map area. Good outcrop is found in scattered, prominent inselbergs, such as Wallaroo Rock, Caenyie Rock, and the one at Two Wells.

The granitoids have been only slightly deformed, though they generally show minor textural modifications. They contain coarse, feldspar–quartz (–muscovite) pegmatite dykes and small stringers of biotite. Their composition is biotite monzogranite, and their grain size is variable. Both K-feldspar (35%) and plagioclase (oligoclase; 30%) are locally slightly porphyritic and enclose smaller feldspar and quartz grains. Quartz (35%) shows deformation lamellae, subgrains, and is locally

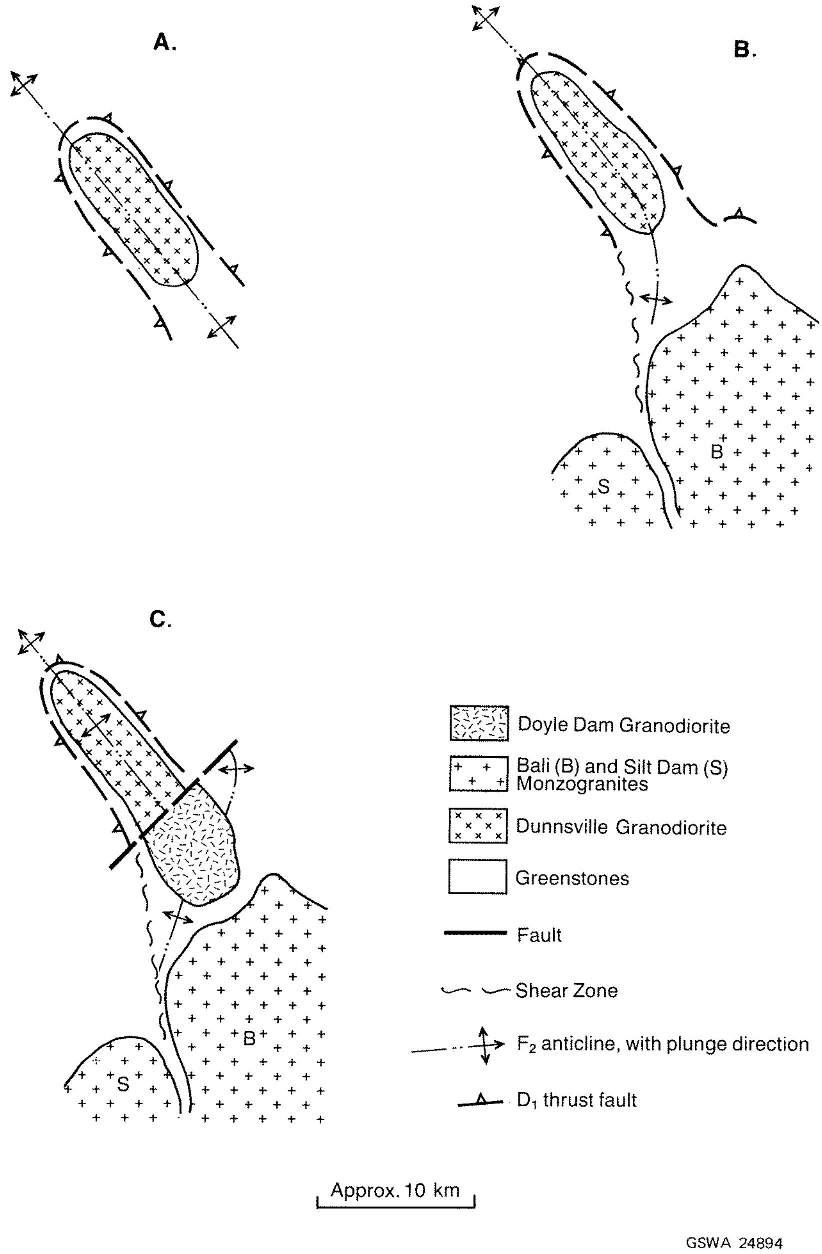

Figure 4. Proposed sequence of granitoid emplacements and their interaction with regional fold and fault structures in the northern Dunnsville area.

(a) D_2 stage: F_2 anticline ('Dunnsville dome') has folded D_1 thrust sheet; the Dunnsville Granodiorite contains the regional S_2 foliation, and may be emplaced before or early during D_2

(b) Post-D_2 to syn-D_3 stage: Instrusion of Bali and Silt Dam Monzogranites resulted in deflection of F_2 fold axial trace, and development of Jaurdi Shear Zone

(c) Late- to post-D_3 stage: Forceful emplacement of Doyle Dam Granodiorite has crosscut and displaced F_2 fold axial trace south of Dunnsville Granodiorite. Simultaneous development of major east-northeasterly striking accommodation fault

recrystallized into an equant polygonal aggregate. Fine dark-brown biotite (<4%) is locally chloritized and contains exsolution crystals of rutile. Fine-grained sphene, short prisms of apatite, and iron-oxides are accessory phases. At Cowarning Rock local domains of biotite granite (syenogranite, 50% K-feldspar) with fine- to medium-grained allotriomorphic textures appear to be enveloped in the dominant monzogranite.

The contact of this granitoid belt with the greenstone is generally poorly exposed, although some observations can be made in the northwest. The granitoid has locally enveloped large blocks of greenstone (e.g. the peridotite northwest of Yarmany Rock), and, elsewhere, apparently reoriented such blocks away from the regional strike. Associated granitoid dykes crosscut the greenstone without any subsequent deformation. The entire granitoid belt, also described as the 'external granites' (Gee et al. 1979), is regarded as late tectonic.

Metamorphism

According to the metamorphic classification of Binns et al. (1976) and Ahmat (1986), the northeastern and southwestern parts of DUNNSVILLE are respectively medium-grade and high-grade domains. Medium-grade domains are low- to mid-amphibolite facies, whereas high-grade domains were formed under mid- to high-amphibolite facies conditions. The same authors introduced the distinction between 'static-' and 'dynamic-style' metamorphism. In the latter, penetrative deformation in mainly high-grade domains has destroyed original textures, whereas in the former many rock types still show original textures because the strain has been concentrated in narrow zones.

Although detailed compositional data on mineral assemblages have not been obtained, the findings of this mapping project support an increase in metamorphic grade from east to west (possibly northeast to southwest). Some layers in the western amphibolite contain clinopyroxene and granoblastic polygonal plagioclase: this suggests upper amphibolite facies. Such amphibolites are interlayered with mica schist containing andalusite and, locally, garnet.

The komatiite and basalt around the Dunnsville dome contain less diagnostic assemblages including tremolite–chlorite and amphibole–plagioclase. Acicular tremolite in high-Mg basalt (*Abm*) commonly shows fine, intricate intergrowths and fine, radiating overgrowths, interpreted by Ahmat (pers. comm. 1988) to indicate conditions at the transition greenschist–amphibolite facies. Their strongly deformed equivalents, tremolite schists, show identical textures from east (Dunn Eight Mile) to west (southwest of Reptile Dam), with the only difference the coarser grain size of the westernmost occurrences. Around Jaurdi, the assemblage actinolite–epidote–plagioclase suggests upper greenschist or epidote–amphibolite facies. Characteristic are the locally curved, sheaf-like, and rosette-shaped amphiboles in hornblende schist derived from both basalt and dolerite–gabbro.

Previous authors (Binns et al. 1976; Archibald et al. 1978; Ahmat 1986) have already commented on the extensive syn- and post-tectonic recrystallization in the higher grade domains. Numerous examples were also found on DUNNSVILLE. The chlorite–tremolite schist derived from the high-Mg basalt commonly shows small domains of a strong foliation defined by a preferred orientation of chlorite and irregularly shaped tremolite. This foliation is partly destroyed by new growth of acicular tremolite at small angles to the foliation plane. In basaltic hornblende schists randomly oriented interlocking hornblende has enclosed trails of fine opaques which are continuous from grain to grain, suggesting the presence of an earlier planar fabric.

In most cases it is difficult to decide the relative timing of these fabrics. For example, strongly sheared D_2 and D_3 fabrics may occur directly adjacent to recrystallized domains. The Bali Monzogranite – greenstone contact shows similar features with locally extensive recrystallization of the sheared granitoid phases as well as hornblende schists. Tremolite schist against both the domal (pre- to syn-D_2) Dunnsville Granodiorite and the Bali Monzogranite (post-D_2 to syn-D_3) shows virtually the same mineralogy and microstructure. Such observations confirm the suggestion of Binns et al. (1976, p. 308) of 'an extended history of deformation and recrystallization under uniform P–T conditions'.

In summary, the northeastern part of DUNNSVILLE is metamorphosed to the greenschist–amphibolite facies transition, with an increase from low- to high-amphibolite facies westwards from the Dunnsville Granodiorite and Bali Monzogranite. The widespread andalusite in metapelites indicates low pressure metamorphism (Binns et al. 1976).

Structure

The regional structure of DUNNSVILLE is discussed in terms of the deformation history outlined by Swager (1989). An early widespread thrusting and recumbent folding event (D_1) was followed by a transpressional deformation regime including regional upright folding (D_2) followed by major sinistral transcurrent faulting plus continued regional shortening (D_3). The emphasis here is on the large-scale structures, because many of the small-scale structures in the exposed mafic rocks are equivocal. Furthermore, information is largely restricted to the eastern part of DUNNSVILLE.

Dunnsville–Ubini area

The repetition of the basalt (*Ab*)–komatiite (*Auk, Aup, Au, Abm*) sequence around the Dunnsville Granodiorite dome is interpreted as a possible D_1 structure. The D_1 thrust fault, across which the sequence is repeated, lies at the top of the 'inner' komatiite unit (Fig. 2), and appears to be bedding parallel in several areas, but more likely is at a small angle to the layering. This interpretation is identical to that of Martyn (1987), and is largely based on the lack of repeated basalt–komatiite successions in other areas along strike, such as the Coolgardie area on KALGOORLIE (Hunter, 1993). Original D_1 fabrics within the thrust faults were probably destroyed by renewed deformation and recrystallization. The D_1 fault is obscured in and along the Jaurdi Shear Zone (Fig. 2). East of the Dunnsville dome, the D_1 structure is faulted and displaced as a result of emplacement of the Doyle Dam Granodiorite (Fig. 2).

A possibly equivalent D_1 thrust fault (Fig. 3) is interpreted to the south of Coolgardie (Hunter, 1993), where it is truncated by the Bali Monzogranite. This would imply the presence of a regionally extensive thrust sheet.

The D_2 deformation resulted in a regional F_2 anticline with the Dunnsville Granodiorite in the core. This anticline is crosscut and displaced by the Doyle Dam Granodiorite. Southwest of the Dunnsville dome, the F_2 axial trace is cut off against the Jaurdi shear zone, and does not reappear further south (Fig. 2). The west-younging basalt–komatiite sequence in the Coondarrie–Ubini area is correlated with the same sequence above the D_1 thrust fault west of the Dunnsville dome. The possible continuation of the regional F_2 anticline is south of Coolgardie (Fig. 2).

The D_2 deformation resulted in a subvertical north-northwesterly striking regional S_2 foliation, developed in both greenstones and the Dunnsville Granodiorite. At some locations, the steep S_2 can be seen to cut across moderately dipping bedding. However, in most cases only S_2 can be observed, and the dip of the sequence cannot be established.

The D_3 Kunanalling Shear Zone — with a sinistral displacement of approximately 12 km (Hunter, 1993; Swager 1989) — is well defined on KALGOORLIE, where it is at least 1 km wide. The shear zone is less well defined on DUNNSVILLE, but consists of a number of widely spaced shears characterized by horizontal and very shallow dipping mineral lineations. At one locality, the sinistral displacement is confirmed by S-C microstructures in felsic porphyry. The shear zones appear to be displaced — even if by relatively small distances — by a fault underlying the Crest Dam – New Crest Dam valley. Northwest of this fault, the shear zones through Dunn Eight Mile and Gorge Dam are interpreted as the continuation of the Kunanalling Shear Zone. However, additional faults, probably related to the Crest Dam fault, appear to have displaced the sequence, including the shear zone.

The post-D_2 intrusion of two major granite bodies has strongly influenced the pattern of the regional deformation structures (Fig. 4). The post-D_2 to syn-D_3 Bali Monzogranite has reoriented the F_2 anticline into a northeasterly strike direction along its northern end. The F_2 anticline is itself transected, and displaced, by the late to post-D_3 Doyle Dam Granodiorite.

To the southwest of the granodiorite the F_2 axial trace can be followed until it terminates against the Jaurdi Shear Zone. This zone is made up of several individual shears, and shows steeply dipping mineral lineations that suggest subvertical movements. The Jaurdi Shear Zone probably developed during granitoid intrusions as an accommodation structure within the greenstones.

To the northeast of the granodiorite, the F_2 axial trace appears to curve from a northeasterly strike to the regional northwesterly strike, until it is cut off against the Kunanalling Shear Zone and/or the Crest Dam fault. Its continuation on the other side of the Crest Dam fault is the regional F_2 anticline that forms the Dunnsville dome. The areally restricted, northwesterly striking fold, west of Crest Dam, is interpreted as having developed during Doyle Dam Granodiorite emplacement. If, as appears the case, the Kunanalling Shear Zone is displaced by the Crest Dam fault, the granodiorite was emplaced towards the end of D_3, or even after D_3.

Little is known about the structure in the poorly exposed northeast corner of DUNNSVILLE, where an ultramafic komatiite sequence (with thin layers of high-Mg basalt to the northeast) appears interlayered with northeast-facing, felsic volcaniclastic rocks. Possibly several major faults have disrupted the sequence in this area.

The structural–stratigraphic correlation of the Dunnsville–Ubini area with the Coolgardie area (Hunter 1988) is illustrated in Figure 3. The D_1 thrust fault, inferred on the basis of repeated lithology, correlates closely with a narrow D_1 shear zone proposed by Hunter (1988). However, a difference between the interpretation in Figure 3 and that of Hunter (1988) is the absence of several F_2 folds within the basalt–ultramafic sequence. The stratigraphic implication is that the Three Mile Hill Dolerite Sill occurs well within the basalt sequence, (i.e. Burbanks Formation, Hunter 1988) rather than below it (Table 1).

Reptile Dam – Bullabulling area

Because of poor exposure, the structure in the Reptile Dam – Bullabulling area is poorly defined. All rocks in this amphibolite facies domain show a strong and pervasive, mostly upright, regional foliation. The only exception is the area between the Bullabulling water reservoir and Stewart Siding, where metamorphic layering in amphibolite is flat lying. The cause of this flat-lying attitude is not known, but may be an underlying granite pluton. Just south of DUNNSVILLE the amphibolites are overlain by metasediments, with a shallowly south-dipping contact. However, Hunter (1988) reported consistently downward-facing sedimentary structures in these beds. Whether this overturning is an early (?D_1) structure, or resulted from granitoid intrusion (post-D_2) into an already folded sequence, is not known.

The western boundary of the area is defined by the irregular intrusive contacts with the late-tectonic 'external' granitoid. These granitoids have enclosed and reoriented large blocks of greenstone. Small, undeformed granitoid dykes cut the sequence. On a regional scale, this western boundary largely coincides with a prominent, almost north-trending, aeromagnetic lineament (the 'Ida lineament';

Fig. 2) which can be followed northwards onto DAVYHURST, RIVERINA, and LAKE BALLARD 1:100 000-scale sheets. The lineament may represent a major tectonic structure separating the Norseman–Wiluna Belt from the 'platform-phase' greenstones to the west (e.g. Groves and Batt, 1984). Further mapping of these sheets will lead to an improved interpretation of this fault zone.

The eastern boundary with the well-defined stratigraphy in the Dunnsville–Ubini area is more enigmatic. In the northern half of DUNNSVILLE a gradual transition from ultramafic to basalt (amphibolite)–sedimentary rocks is apparent. However, on a regional scale, rock units are cut out progressively from north to south (Fig. 2). This is particularly clear to the south of the railway line where porphyritic basalt (*Abp*), felsic schist (*Asf*) and amphibolite (*Ama*), which show some open folding, appear to be truncated against a possible major fault or shear zone underlying the major drainage system. The open folds can be interpreted as being formerly en echelon along such a shear zone, and would then indicate a sinistral movement component. The northern continuation of this shear zone is not known, but may be 1–2 km east of Thirty Two Mile Dam and through Top Dam.

The porphyritic basalt (*Abp*) forms a continuous marker unit on DUNNSVILLE, even though it is 'pushed aside' by the Silt Dam Monzogranite (which intruded across the above proposed shear zone). The lens shape of the sequence to the west of this marker unit may be stratigraphic, or tectonic in origin. For example, slices of ultramafic rocks have been mapped in the field and inferred from aeromagnetics. These isolated occurrences may be the attenuated trail of a formerly continuous unit of komatiites (e.g. spinifex textures reported on DAVYHURST to the north, in mineral exploration reports) or originally separate ultramafic intrusives. The indications that the ultramafic slices occur along a major tectonic break (see above) and within a high-strain and metamorphic-grade domain, may favour the former suggestion.

Economic geology

The Jaurdi and Dunnsville gold mining centres are in the Kunanalling District of the Coolgardie Mineral Field. They were established around the turn of the century, but most mines maintained substantial production for only a few years (Gibson, 1908). In all centres, alluvial gold has been won. Production statistics (W.A. Department of Mines) for mines that have produced more than 5 kg gold are shown in Table 2. Most of this gold (which represents only a minimum figure) was won in the early part of the century. The only major discovery so far during the late 1980s is the low-grade lateritic Bullabulling deposit at the southern boundary of DUNNSVILLE. At the time of writing (1988) continuing exploration indicates the presence of a major shear zone hosting the primary mineralization.

The mineralization at the old mining centres occurs commonly in quartz veins within narrow felsic-porphyry sills hosted by the basalt unit (*Ab*). Contacts with basalt, dolerite or gabbro are also favourable sites of mineralization. In other words, gold mineralization is mostly localized by the typical interflow slate–dolerite or gabbro–felsic porphyry association, which can be mapped as narrow concordant zones throughout the basalt. These zones are commonly zones of intense deformation, as shown by strong foliation development. Microstructural observations on samples from mine dumps suggest that dolerite or gabbro intrusion predated that of felsic porphyry. Although many occurrences of gold mineralization are associated with felsic porphyry, there are many more unmineralized porphyry dykes and sills throughout the area.

Gibson (1908) described the main mines being worked in 1907. His observations at Jaurdi and Dunnsville indicate that the mineralized quartz veins and lodes, though irregular and pinching-and-swelling, are generally parallel to the regional strike (north-northwesterly) and dip westwards at about 45°. It is commonly difficult to

Table 2. Production statistics of major mines on DUNNSVILLE (Production more than 5 kg Au)

Mining centre	*Mine*	*Ore treated*	*Gold produced (kg)*	*Alluvial and/or dollied gold (kg)*	*Main production period*
Dunnsville	Wealth of Nations	15 977	218.213		1898–1909
	Wealth of Nations Central	233	5.323	3.293	1898
	Min Min Light	18 252	271.038	25.974	1937–1940
	Herbert	196	5.083		1908–1910
Jaurdie Hills	Jaurdie	4 951	4.951		1900–1906
	Jaurdie Enterprise and Jaurdie Enterprise Extended	10 516	121.872		1907–1913
	Derry's Own	1 117	11.240	minor	1907–1911
	Pride of the Jaurdies	12 990	370.655		1897–1918
	Pride of the Jaurdies North	3 218	92.526		1899–1915

establish whether they have the same dip as the primary layering. In one example (Dunnsville North), a complex vein system was observed in a costean, with folded and boudinaged quartz veins rotated parallel to the regional foliation and steeply dipping en echelon veins, suggesting a nearly horizontal movement. The bulk of production for each area was from one or two major lode systems (Table 2).

The Jaurdi Shear Zone is a major structure controlling gold deposition. This shear zone, with steep, down-dip mineral lineations, is interpreted as an accommodation shear related to emplacement of the Bali and Silt Dam Monzogranites, and possibly the Doyle Dam Granodiorite. The main producing leases were Jaurdie Enterprise and Derry's Own.

At Dunn Eight Mile, the main line of workings stretches northwards to Gorge Dam, and coincides with a major inferred shear zone that is proposed as the continuation of the D_3 Kunanalling Shear Zone. Again, underground workings are concentrated along quartz veins within felsic porphyry sills and/or porphyry–slate–basalt or dolerite contacts.

In the Coondarrie area, small-scale porphyry-related workings occur within amphibolitized basalts. In addition, several small mines are located along the western, i.e. upper, contact of the ultramafic schists, with two operations (Pool Man's Wealth, First Find) within high-grade amphibolites, and one eastwards within talc–carbonate schists (First Find East). Small-scale mining is presently underway along the basalt–ultramafic contact 250 m north of the Great Eastern Highway. In the same area a large opencut operation (Bullabulling project) is planned to mine a shallow, low-grade lateritic gold deposit (published mineable reserves in November 1988: 2.4 Mt. at 1.1 g/t).

Extensive nickel exploration in the late 1970s on the ultramafic rocks failed to delineate any substantial nickel sulfide mineralization. Amblygonite and lepidolite (*Li*), within pegmatite dykes intruded into ultramafic rocks, have been mined on a small scale at Coondarrie.

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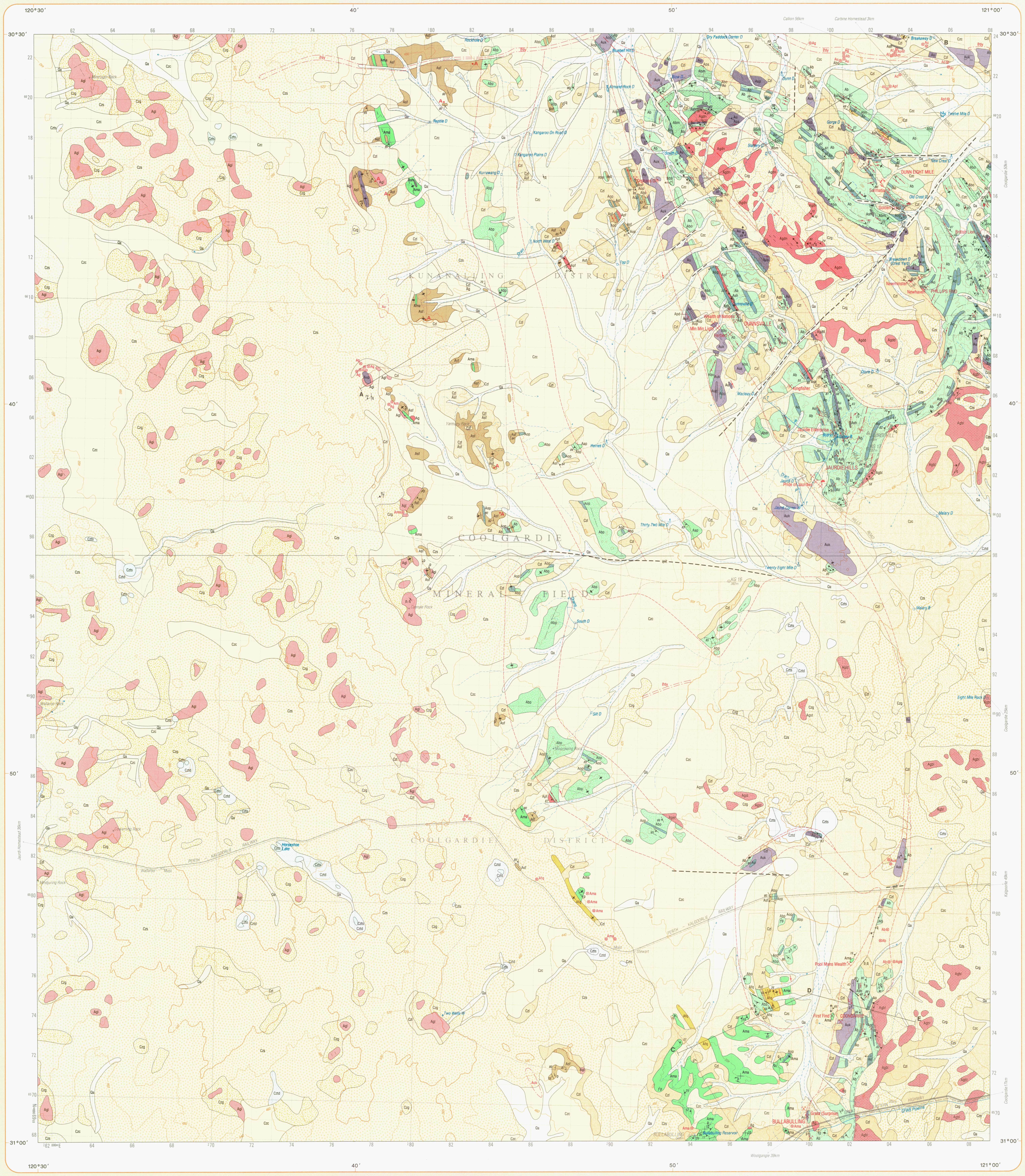
DUNNSVILLE

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET 3036



CAINOZOIC

Qa — Alluvium — clay, silt, sand and gravel in channels

Czts — Evaporite interbedded with clay and sand in playas
Cztd — Sand, silt and gypsum in stabilized dunes adjacent to playas

Czc — Colluvium — gravel, sand as sheetwash and talus
Czg — Quartzo-feldspathic sand over granitoid rock
Czs — Sand plain — yellow sand with limonitic pisoliths near base
Czl — Laterite and reworked products

PROTEROZOIC

Edy — Mafic and ultramafic dykes — inferred

ARCHAEAN

Veins and dykes: p — pegmatite; g — granite; q — quartz

Ag — Granitoid rock, unsubdivided
Agl — Monzogranite with minor syenogranite; late tectonic (post-D3) granitoids; discordant contacts with greenstone sequence
Agbl — **BALI MONZOGRANITE:** post-D2 to syn-D3 granitoid; K-feldspar-phyric; intense contact-parallel foliation with down dip mineral lineation
Agst — **SILT DAM MONZOGRANITE:** post-D2 to syn-D3 granitoid; K-feldspar-phyric; intense contact-parallel foliation with down dip mineral lineation
Agdd — **DOYLE DAM GRANODIORITE:** post-D2 to syn-D3 granitoid; massive to weakly foliated; discordant contact with greenstone sequence
Agdn — **DUNNSVILLE GRANODIORITE:** pre-to syn-D2 granitoid: moderate pervasive foliation with subhorizontal mineral lineation; strongly sheared contact with greenstone sequence, with subhorizontal and steep mineral lineation

Apf — Felsic porphyry; feldspar and/or quartz phenocrysts
Apa — Albite-rich porphyry
Apd — Dacite porphyry
Apg — Granite porphyry
Porphyry dyke or sill; Apf unless otherwise indicated

Asf — Pelitic and felsic volcaniclastic sediments; including grey slate, quartz-muscovite schist with local andalusite porphyroblasts, garnet-biotite schist and quartzo-feldspathic schist
Ash — Slate and chert, black to grey; mainly as thin interflow sediments; possibly tuffaceous

Af — Felsic volcanics and volcaniclastic sediments
Afq — Quartz-phyric felsic schist; derived from tuffaceous rock or rhyolite

Ao — Dolerite and minor pyroxenite; hornblende schist
Aog — Gabbro, weakly layered; amphibolite and hornblende schist
Aop — Dolerite, plagioclase-phyric; predominantly sills

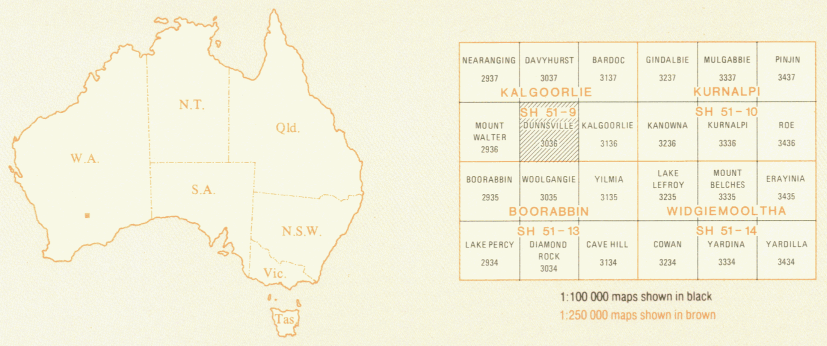
Ab — Basalt; including doleritic textured layers and lenses; amphibolite and actinolite schist
Abo — Basalt, ocelli-bearing; tremolite/actinolite schist
Abp — Basalt, plagioclase-phyric; commonly vesicular; with thin feldspar-phyric dolerite bands; hornblende schist and amphibolite
Abm — High-Mg basalt; characterized by sheaf and/or random amphibole spinifex texture after pyroxene
Ama — Amphibolite; including clinopyroxene-bearing amphibolite; well-developed metamorphic layering
Aap — Andesite, plagioclase-phyric

Au — Ultramafic schist; tremolite ± chlorite schist, talc-chlorite ± carbonate schist
Auk — Komatiite; with olivine spinifex-texture; with minor Aup and Abm
Aup — Ultramafic rock, massive; serpentinized peridotite with olivine orthocumulate texture; local talc-carbonate alteration

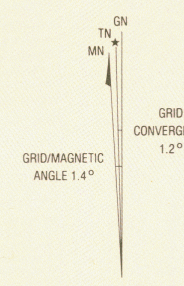
Greenschist-amphibolite facies transition to amphibolite facies metamorphism

Geological boundary
observed
interpreted
interpreted from aeromagnetic data
Fault, inferred; interpreted movement
Shear zone, locally concealed
Fold axis, showing plunge
major anticline
major syncline
minor
Bedding
inclined
vertical
horizontal
Igneous lamination
inclined
vertical
Way-up indicator
igneous layering
pillow structures
sedimentary
Dominant metamorphic foliation
inclined
vertical
Strongly foliated rock
Mineral lineation
inclined
horizontal
Cleavage, widely spaced
inclined
vertical
Joint, fracture, extension vein
inclined
vertical
Air photo lineament
foliation trend in greenstone
fracture patterns in granite
foliation trend (section)

Mineral field district boundary
Highway with national route marker
Formed road
Track
Fence, generally with track
Powerline
Railway with siding — Stewart
Railway abandoned
Locality — Ubini
Transmitter or repeater site; building
Horizontal control; major, minor
Sand dune
Breakaway
Contour line, 20 metre interval — 380
Watercourse, ephemeral
Pipeline
Bore
Well
Dam
Tank
Windpump
Mining centre — DUNNSVILLE
Mining locality — DUNN EIGHT MILE
Mine or open cut (gold unless otherwise indicated) — Wealth of Nations
Alluvial workings
Battery, abandoned
Mineral exploration drill hole or other subsurface data
Interpreted subsurface lithology — Auk
Mineral occurrence
Andalusite — A
Lepidolite, amblygonite — Li



1:100 000 maps shown in black
1:250 000 maps shown in brown



True north, grid north and magnetic north are shown diagrammatically for the centre of the map. Magnetic north is correct for 1983 and moves westerly by 0.1° in about 7 years.

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MINISTER FOR MINES
D.R. KELLY DIRECTOR GENERAL OF MINES

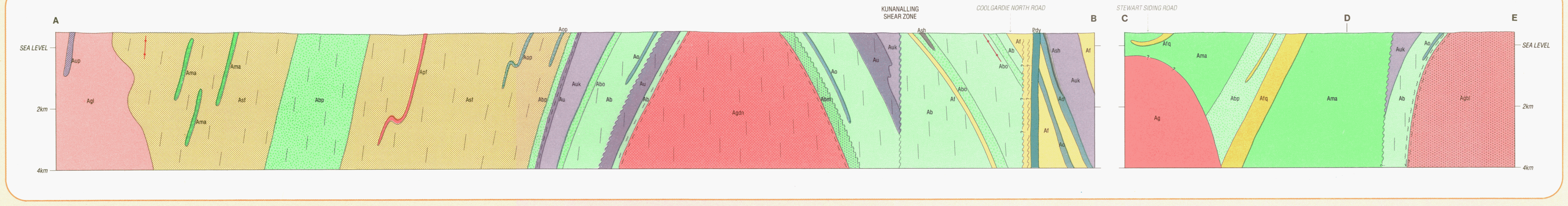
P.E. PLAYFORD
DIRECTOR, GEOLOGICAL SURVEY
OF WESTERN AUSTRALIA

SCALE 1:100 000

1000 Metres 0 1 2 3 4 5 6 7 8 9 10 Kilometres

TRANSVERSE MERCATOR PROJECTION
Grid lines indicate 1000 metre interval of the Australian Map Grip Zone 51

DIAGRAMMATIC SECTIONS



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DUNNSVILLE

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