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Notes on the Geology of the Halls Creek 1:100 000 Sheet area, East Kimberley, Western Australia: Results of 1990 Fieldwork.

Record 1991/94

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D.H. Blake

ALS AND LAND USE PROGRAM

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Geoscience for Australia's future

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

Minister: The Hon. Alan Griffiths

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ABSTRACT

The area mapped, in the northern half of the Halls Creek 1:100 000 Sheet area, contains outcrops of Proterozoic Halls Creek Group (Ding Dong Downs Volcanics, Saunders Creek Formation, Biscay Formation, and Olympio Formation), Moola Bulla Formation, Lamboo Complex (Bow River Granite, McIntosh Gabbro, and Tickalara Volcanics), and Kimberley Group (King Leopold Sandstone and Carson Volcanics). Granophyre and microgranite previously mapped as Sophie Downs Granite are overlain unconformably by Saunders Creek Formation, and are considered to be correlatives of the Ding Dong Downs Volcanics.

The sedimentary and bimodal volcanic rocks of the Halls Creek were first folded and metamorphosed during the Barramundi Orogeny, at around 1870 Ma. The Moola Bulla Formation may immediately postdate this orogeny. Subsequent emplacement of Bow River Granite into the Halls Creek Group, at around 1850 Ma, was closely followed by intrusions of McIntosh Gabbro. These mafic intrusions are considered to have caused partially melting of still hot granite and contact hornfels to form net-veined complexes and migmatitic Tickalara Metamorphics. After 1850 Ma but before 1800 Ma, the area was eroded and then overlain by the Kimberley Group.

INTRODUCTION

In August and September 1990 D.H.Blake carried out detailed reconnaissance geological mapping in the northern half of the Halls Creek 1:100 000 Sheet area, in the northwest of the Gordon Downs 1:250 000 Sheet. In addition he took part in geological excursions of the east Kimberley, with K.A.Plumb and R.G.Warren (BMR) and T.J.Griffin and I.M.Tyler of the Geological Survey of Western Australia (GSWA), and to the west Kimberley with T.J.Griffin, I.M.Tyler, and J.S.Myers (GSWA) and R.D.Shaw (BMR). Also in August and September, R.G.Warren carried out a preliminary investigation of regional metamorphism in the Halls Creek area, especially in the vicinity of the Armanda Sill, and T.J.Griffin and I.M.Tyler commenced geological mapping of the Angelo and Dockrell 1:100 000 map areas in the east of Mount Ramsay 1:250 000 Sheet. These activities were undertaken as part of the Kimberley-Arunta NGMA (National Geoscience Mapping Accord) Project, started in 1990 and due to be completed in 1995. The aims of the Kimberley-Arunta NGMA Project are:

- To determine, through systematic mapping, the nature, timing, and distribution of significant geological events in and between the east Kimberley, the Granites-Tanami, and west Arunta areas of the North Australian Craton.
- To determine the extent of prospective basement beneath thin cover.
- To describe styles of mineralisation that can be used as predictive exploration models.
- To provide geological and mineral resource information necessary for land use decisions.

The Halls Creek 1:100 000 Sheet area was previously mapped nearly 30 years ago, during the joint BMR/GSWA survey of Gordon Downs 1:250 000 Sheet area in 1962-64 (Gemuts & Smith, 1968). This work, and BMR Bulletin 106, "Geology of the Kimberley region, Western Australia: the east Kimberley" by Dow & Gemuts (1969), which established the geological framework for the east Kimberley, form the foundation for the present investigations. The northern part of the Halls Creek map area lies within the north-northeast trending Halls Creek Orogen of Tyler & Griffin (1990), also known as the Halls Creek Orogenic Domain (Hancock & Rutland, 1984) and Halls Creek Mobile Zone (Plumb,1990). Most of the main stratigraphic and intrusive units of the orogen are well exposed and readily accessible in the area.

The mapping in 1990 was carried out using 1:25 000 colour airphotos taken in July 1990 by the Department of Lands Administration (WA); the new photography covers the Halls Creek, Ruby Plains, Angelo, and Dockrell 1:100 000 Sheets. Some results of the mapping are summarised in BMR (1991).

GENERAL GEOLOGY

The stratigraphic scheme established by Dow & Gemuts (1969) for the older Precambrian rocks of the east Kimberley region, together with a modified scheme based on the 1990 mapping in the northern part of the Halls Creek map area, are shown in Figure 1. A locality map with simplified geology is shown in Figure 2.

The main structural features in the mapped area are fold domes in the east, which include the Saunders Creek and Sophie Downs Domes, and a series of major faults, including the Halls Creek Fault, trending between north and northeast. The oldest rocks exposed are assigned to formations of the Halls Creek Group: from oldest to youngest, these are the Ding Dong Downs Volcanics, and the Saunders Creek, Biscay, and Olympio Formations. Rocks previously mapped as Sophie Downs Granite predate Saunders Creek Formation, and may correlate with Ding Dong Downs Volcanics. Another unit, the Moola Bulla Formation, fault-bounded where examined, is presumed to postdate the Halls Creek Group. The Halls Creek Group was folded about upright north-northeasterly trending axial planes, and developed an axial planar cleavage, before emplacement in the west of granite (Bow River Granite) and dolerite/gabbro (McIntosh Gabbro). These intrusions, and associated Tickalara Metamorphics, predate the Kimberley Group, represented in the area by King Leopold Sandstone and Carson Volcanics, and are cut by felsic and mafic dykes. Timing of geological events, indicated from ion-probe U-Pb zircon geochronology by R.W.Page (1988; Page & Hancock, 1988; BMR, 1988; BMR, 1989), is as follows: Ding Dong Downs volcanism, about 1910 Ma; Biscay Formation deposition, about 1870 Ma; folding of Halls Creek Group = Barramundi Orogeny, around 1870 Ma; intrusion of Bow River Granite and McIntosh Gabbro, around 1850 Ma (the Whitewater Volcanics to the west of the mapped area, comagmatic with Bow River Granite, are dated at 1850 Ma); deposition of Kimberley Group, after 1850 Ma but before 1800 Ma (age of Hart Dolerite, which intrudes Kimberley Group west and north of mapped area).

DESCRIPTIONS OF MAPPED ROCK UNITS

HALLS CREEK GROUP

Ding Dong Downs Volcanics

Distribution. In centre of Saunders Creek Dome (Gemuts & Smith, 1968); probably in Sophie Downs Dome, where previously mapped as Sophie Downs Granite, and smaller dome to north - Prospect Creek Dome (centred at GR870045) - where previously assigned to Biscay Formation. Also been reported (Ririe, 1989) from core of Castle Creek anticline in Antrim 1:100 000 map sheet area to east.
Thickness. >1000 m.
Rock types. *Saunders Creek Dome* : weakly to strongly foliated metabasalt, commonly epidotic, amygdaloidal; subordinate massive to finely laminated and schistose fragmental felsic volcanics (euhedral to fragmental quartz and feldspar crystals and lensoid siliceous aggregates possibly representing metamorphosed pumice in fine-grained quartzofeldspathic groundmass with muscovite and biotite), flow-banded metarhyolite, phyllitic felsic and mafic tuffs, cherty felsic tuff, mafic and felsic volcaniclastic sandstone and siltstone; minor calcareous rocks. *Sophie Downs Dome*: porphyritic leucocratic granophyre (quartz + sodic plagioclase + microcline phenocrysts and some mafic aggregates in a mainly very fine-grained groundmass of micrographic quartz and alkali feldspar with minor biotite and opaques), fine-grained heterogeneous and partly recrystallised 'leucogranite' with fluorite; metarhyolite with spherulites (altered glass) at top in east (GR 831966), rhyolitic metabreccia of flow-margin type at top in west (GR 797995); upper part in south consists of finely laminated felsic tuff (phenocrysts of sodic plagioclase, beta-quartz and microcline in heterogeneous fine to very fine-grained quartzofeldspathic mosaic with biotite and/or pale amphibole), interbanded mafic and felsic tuff/siltstone, and volcaniclastic sandstone. *Prospect Creek Dome*: amygdaloidal metabasalt, schistose felsic and mafic tuffs, chert (felsic tuff?).
Relationships. *Saunders Creek Dome*: overlain concordantly by sandstone of Saunders Creek Formation; intruded by mafic (amphibolitic) and felsic (quartzofeldspathic) sills.

Sophie Downs Dome: overlain by sandstone of Saunders Creek Formation or (e.g., near GR 830960, GR 820935, and GR 750895), mafic volcanics of Biscay Formation; concordant contact where bedded rocks present above and below contact, but unconformity evident in north (near GR815005), where basal bed of Saunders Creek sandstone contains pebbles of vein quartz together with small rounded boulders of 'Sophie Downs Granite' identical to that immediately below the sandstone. Intruded by irregular foliated mafic sheets and, in south (GR 768874) by veins of non-foliated medium-grained to pegmatitic leucogranite which penetrate up into overlying Biscay Formation. *Prospect Creek Dome*: overlain apparently concordantly by metabasalt and mafic and felsic tuffaceous metasediments of Biscay Formation.

Age. Felsic metavolcanics from Saunders Creek Dome dated at about 1910 Ma (ion-probe zircon age – Page, in BMR, 1989). Nd T/chur model ages of 1.9 Ma and 2.0 Ma for Ding Dong Downs Volcanics and Sophie Downs "granite", respectively, have been determined by S-S Sun (BMR, personal communication, 1991).

Remarks. Previously mapped Sophie Downs Granite in the Sophie Downs Dome consists partly of bedded volcanics and volcaniclastics, but mostly of massive granophyre and fine leucogranite representing either extrusive rhyolitic lava domes or high-level (subvolcanic?) intrusions which predate, rather than intrude (e.g., Gemuts & Smith, 1968), Saunders Creek Formation. Unconformable contact of granophyre with overlying Saunders Creek Formation discovered by T.J.Griffin and R.G.Warren on north side of Sophie Downs Dome in August 1990; may not represent a regionally significant time gap. Presence of amygdaloidal mafic lavas, lack of pillow lavas, and paucity of clastics showing sedimentary structures indicate that Ding Dong Downs volcanism may have been largely subaerial. Thinly layered rocks typically show a pronounced foliation parallel to the layering and a mineral elongation lineation; granophyre in Sophie Downs Dome is generally weakly foliated.

Saunders Creek Formation

Distribution. Around Saunders Creek Dome and parts of Sophie Downs Dome.

Thickness. 0-200 m.

Rock types. Thick to thin-bedded quartzose to highly feldspathic and lithic sandstone showing high-angle cross-bedding and, especially near base, climbing ripples; granule to pebble conglomerate common at or near base; sedimentary structures commonly outlined by heavy mineral laminae; subordinate interbedded schistose biotite-rich metasiltstone and metagreywacke; laminated felsic tuff (fine to very fine-grained with scattered phenocrystic, euhedral sodic plagioclase) at GR 777881.

Relationships. Overlies Ding Dong Downs Volcanics concordantly (conformably?) and unconformably (see above); passes conformably upwards (and laterally into?) Biscay Formation – contact taken at base of lowest mafic lava.

Age. Younger than Ding Dong Downs Volcanics dated at about 1910 Ma and older than Biscay Formation dated at about 1870 Ma. Detrital zircons from Saunders Creek arkose in Saunders Creek Dome (BMR sample no. 87598028) give ages of around 3300 Ma and 3600 Ma (Page, in BMR, 1988).

Remarks. Sedimentary structures and restricted distribution indicate Saunders Creek Formation is probably a fluvial unit. High quartz content and ages of detrital zircon imply a major detrital component from a source area outside the present Kimberley region.

Biscay Formation

Distribution. Widespread in central and eastern parts of mapped area.
Thickness. >1000 m; difficult to estimate because of structural complexities, especially tight folding.
Rock types. In lower part: amygdaloidal to massive metabasalt, schistose mafic and subordinate felsic tuff, basaltic sandstone and siltstone, minor calcareous beds. Middle part: abundant calcareous beds - marble, calc-schist, calcareous siltstone and sandstone, calc-silicate rocks; also banded chert ("BIF"), purple and grey laminated siltstone, felsic porphyry (ignimbrite?), thinly bedded felsic and mafic tuff, basaltic sandstone, calcareous polymictic conglomerate (at GR 600911), and metabasalt. Upper part: subgreywacke and siltstone with minor carbonates and mafic volcanics. Two bodies of metarhyolite in west, centred at GR 580905 and GR 750085, are tentatively regarded as part of Biscay Formation.
Relationships. Conformably overlies Saunders Creek Formation and concordant on Ding Dong Downs Volcanics; intruded by a few mafic sills (Woodward Dolerite); cut by medium-grained to pegmatitic leucogranite veins on south side of Sophie Downs Dome (GR 768874); intruded in west by Bow River Granite and McIntosh Gabbro and in east (GR 941047) by feldspar porphyry (euhedral plagioclase phenocrysts of all sizes up to 5 cm across in fine-grained chloritic groundmass). Faulted contact with Olympio Formation in east.
Age. Zircon crystals in tuff from Brockman prospect, to south of area mapped, indicate an age of about 1870 Ma (Page, in BMR, 1989). Page & Hancock (1989) obtained an age of 1854 ± 5 Ma for a felsic sill within, but thought to be contemporaneous with, the Biscay Formation; however, as the dated rock does not appear to be foliated and has a microgranitic igneous texture, whereas felsic extrusives within the Biscay Formation are invariably recrystallised and, unless hornfelsic, are foliated, the dated sill may postdate the foliation-forming event (=Barramundi Orogeny, and hence may be appreciably younger than the Biscay Formation.
Remarks. Probably represents shallow water shelf-type sedimentation and shallow water to subaerial volcanism. The formation was tightly folded about mainly north-northeast trending axes during Barramundi Orogeny, and a subvertical axial planar foliation is generally prominent.

Olympio Formation

Distribution. Easternmost part of mapped area.
Thickness. >1000 m.
Rock types. Micaceous metagreywacke and metasiltstone: thin to thick bedded; lode casts, scour marks, and graded bedding common; schistose. Rare quartzitic and calcareous beds.
Relationships. Only seen in fault contact with Biscay Formation, but reported to overlie this formation conformably (e.g., Dow & Gemuts, 1969).
Age. Probably about 1870 Ma, as folded and cleaved during Barramundi Orogeny, but overlies Biscay Formation.
Remarks. A widespread turbiditic unit presumably deposited in deeper water than most of Biscay Formation. A probable correlative of similar turbiditic units in central and northern Australia – Killi Killi beds of The Granites-Tanami region, Burrell Creek Formation of the Pine Creek Inlier, Lander Rock beds of the Arunta Block, and Warramunga Group of the Tennant Creek Inlier (e.g., Blake, 1978).

WOODWARD DOLERITE

Remarks. Outcrop previously mapped as Woodward Dolerite on north side of Sophie Downs Dome (Gemuts & Smith, 1968) consists mainly of extrusive metabasalt belonging to Biscay Formation. However, Ding Dong Downs Volcanics and Biscay Formation in mapped area include some metadolerite sills that may be related to Woodward Dolerite exposed to the south.

MOOLA BULLA FORMATION

Distribution. Fault-bounded outcrops east of Halls Creek. Exposures examined along Elvire River upstream from Carolina Pool and 6 km to northeast.
Rock types. Grey and bluish grey sandy, silty, and pebbly mudstone; pebble and granule 'greywacke' conglomerate. Bedding planes generally poorly defined. High to low-angle cross-bedding outlined by heavy mineral laminae present upstream from Carolina Pool.
Relationships. Along Elvire River: fault contacts with King Leopold Sandstone of Kimberley Group to NW and with Olympio Formation of Halls Creek Group to SE. To NE: fault contact with King Leopold Sandstone to SE and probable fault contact with Biscay Formation to NW.
Remarks. Folded about upright northeast-trending axial planes, with an axial planar cleavage, along Elvire River; more intensely cleaved to northeast. Less recrystallised/metamorphosed and less foliated along Elvire River than nearby Halls Creek Group. May represent molasse-type deposits related to uplift associated with the Barramundi Orogeny, and hence may be significantly younger than the Halls Creek Group but older than the Kimberley Group; deformation of Moola Bulla Formation, like that of adjacent Kimberley Group, can be attributed to post-1800 Ma tectonism.

LAMBOO COMPLEX

As described by Dow & Gemuts (1969) and Gemuts (1971), the Lamboo Complex consists of felsic and mafic plutonic rocks, shown as Bow River Granite and McIntosh Gabbro on the Gordon Downs geological map (Gemuts & Dow, 1968), and Tickalara Metamorphics. All three units were examined during 1990 in the northern part of the Halls Creek area and also at Turkey Creek to the north, in Dixon Range 1:250 000 Sheet area. In many outcrops visited the felsic and mafic rocks occur together in net-veined complexes (descibed below), some of which also involve Tickalara Metamorphics. Most of these metamorphics are probably high-grade equivalents of the Halls Creek Group exposed to the east (e.g., Griffin & Grey, 1990).

Bow River Granite

Distribution. Forms large batholith, elongated north-northeast, within the Halls Creek Orogen, comprising many individual plutons; extensively exposed in northwest Halls Creek area.
Rock types. Medium to coarse biotite granite and biotite tonalite with abundant phenocrysts of pink feldspar up to 2 cm long; minor sparsely porphyritic biotite granite, leucogranite, microgranite. Generally not foliated, but an igneous foliation is apparent in places, shown by alignement of phenocrysts and inclusions.
Relationships. Intrudes and hornfelses Halls Creek Group; forms net-veined complexes with McIntosh Gabbro – see below; cut by felsic (quartz-feldspar porphyry) and mafic dykes.

Age. Around 1850 Ma; considered to be comagmatic with Whitewater Volcanics (e.g., Wyborn, 1988; Wyborn & others, 1987), dated at 1850± 5 Ma (Page & Hancock, 1988), which are exposed to west of mapped area.

McIntosh Gabbro

Distribution. Taken to include all mafic intrusions, other than dykes and thin sills, in northern half of Halls Creek map area (Gemuts & Smith, 1968); extensive outcrops in western and central parts; includes Armanda Sill of Gemuts (1971).
Rock types. Dolerite and gabbro – retain igneous mineralogy, including primary olivine in some cases; metadolerite and metagabbro – contain metamorphic amphibole; generally not foliated.
Relationships. Intrudes and hornfelses Halls Creek Group; forms net-veined complexes with Bow River Granite – see below.
Age. ?1850 Ma; probably several generations (e.g., Plumb & others, 1985); mainly slightly younger than, but may overlap in age with, Bow River Granite.

Net-veined complexes

Distribution. Widespread in northwestern part of mapped area; particularly well displayed near Shepherds Bore (e.g., at GR 547893, GR 543905, and GR 545910) and to north (e.g., at GR 582028, GR 570065, and GR 655003); also in central north, adjacent to Armanda Sill (e.g., at GR746083 – R.G.Warren, personal communication, 1990).
Rock types. Granite, dolerite, heterogeneous hybrid rocks of intermediate composition, and metasedimentary and metavolcanic xenoliths. Dolerite and some mafic hybrids ('quartz dolerite' and 'diorite') occur as inclusions ranging from less than a metre to tens of metres across in granite.
Many mafic inclusions are angular in shape, but others have rounded forms resembling pillows in pillow-lavas except that their contacts with adjacent more felsic rock, though generally sharp, are highly irregular in detail (see BMR, 1991; also Plate 4 in Gemuts, 1971), with rounded protruberances of mafic rock alternating with pointed embayments of felsic rock in cumulose fashion. At separate exposures, the proportions of felsic to mafic rock and of pillow-like to angular mafic inclusions range from >10:1 to >1:10.
Mafic pillows, especially the larger ones, are cut by sinuous and straight-sided felsic veins connected to the enclosing granitic rock. Some sinuous veins are funnel-shaped and terminate in the pillow interior. All stages can be found from pillows with no felsic veins, to pillows that are fragmented by networks of veins, to isolated fragments of dismembered pillows, recognisable because, though mainly angular, one of their sides has an irregular cumulose outline; some of these angular fragments resemble "slices of cake", the "cake" being the original pillow. Most other angular mafic inclusions in the net-veined complexes could be derived from the interiors of completely dismembered pillows.
The mafic pillows generally have rims a centimetre or so wide that are darker than the rest of the pillow because of a higher proportion of dark minerals (especially biotite and magnetite) and a commonly finer grain-size. Most angular mafic fragments do not have such rims. Pillows thin-sectioned have igneous textures, but some angular inclusions have equigranular hornfelsic textures.
The more felsic rock in contact with the mafic inclusions ranges from leucogranite, biotite granite and biotite tonalite to heterogeneous hybrid diorite. Feldspar phenocrysts, where present, are generally smaller and less well-shaped than those in granite nearby, and in thin-section some are seen to have corroded outlines and sieved interiors suggestive of

partial melting. Intermediate hybrid rocks are best developed where there are concentrations of mafic intrusions.

Relationships. Contains inclusions of partially melted (migmatitic) deformed Halls Creek Group-type rocks (= Tickalara Metamorphics). Cut by rhyolitic (quartz-feldspar porphyry) dykes. Overlain unconformably by King Leopold Sandstone of Kimberley Group near Mount Barrett (e.g., at GR 462900).

Age. Probably around 1850 Ma; postdates main deformation of Halls Creek Group (Barramundi Orogeny).

Remarks. Net-veined complexes of this type are a common feature of many Proterozoic areas in Australia (e.g., Blake, 1981; 1987). They result either from commingling of felsic and mafic magmas, in which case the two components of the complex are of essentially the same age, or from commingling of mafic magma and felsic melt derived from pre-existing granitic rock. In the Halls Creek area the textural evidence indicates that the mafic magma (= McIntosh Gabbro) was probably intruded into already crystallised granitic rock (Bow River Granite) which then became partially melted and remobilised. The mafic magma chilled against the felsic melt and solidified, preventing widespread mixing of the two liquids, while part of the felsic melt became superheated and consequently less viscous than normal granitic magma, and also less viscous than adjacent crystallising mafic magma, so that the mafic component formed inclusions within, and was veined by, the felsic component, rather than the other way round. The common occurrence at a single exposure of pillows and pillow fragments showing a range in composition, and also in degree of alteration and contact-type metamorphism, can be attributed to several separate, though closely spaced in time and place, intrusions of mafic magma. Although the net-veined complexes indicate that the Bow River Granite predates the McIntosh Gabbo, the difference in age between the two units is probably small. This is because, for the relatively large amount of melting (of granite) to have taken place, the granite would probably have had to have been still very hot, and perhaps not completely crystallised, when the mafic magma was intruded. This has implications for the development of the Tickalara Metamorphics, as discussed below.

Tickalara Metamorphics

Distribution. Numerous small outcrops in western and central part of mapped area.

Rock types. Migmatitic metasediments, including metapelite, meta-arenite, and calcsilicate rocks – show "swirly" fine banding and also quartzofeldspathic "sweats" or leucosomes indicative of partial melting; also non-migmatitic hornfelsic metasediments and mafic and felsic metavolcanics.

Relationships. In the area mapped, migmatitic Tickalara Metamorphics are restricted to immediate vicinity of net-veined complexes, where they are intruded by, and form inclusions within, Bow River Granite (e.g., near GR 555055). Non-migmatitic hornfels is intruded by Bow River Granite and McIntosh Gabbro.

Age. Ion-probe age of 1854 ± 6 Ma reported by Page & Hancock (1988) for zircon from leucogranite within migmatitic Tickalara Metamorphics near Turkey Creek (Dixon Range 1:250 000 Sheet) probably dates the net-veined complex at this locality.

Remarks. Little doubt remains that most or all of Tickalara Metamorphics correlates with Halls Creek Group (probably mainly Biscay Formation). The close spacial association with net-veined complexes, perhaps best displayed in creek exposures 2 km W of Turkey Creek in Dixon Range 1:250 000 Sheet area, near GR 150170 (where dolerite dykes, intruding migmatitic metasediments merging into heterogeneous granitic and intermediate hybrid "igneous" rocks, can be seen to pass laterally into pillowed dolerite), suggests a probable genetic link with Bow River Granite and McIntosh Gabbro. A possible scenario is that at around 1850 Ma, shortly after the Barramundi Orogeny, the Bow River Granite was emplaced within, and contact metamorphosed, the previously folded and regionally metamorphosed Halls Creek Group. The granite emplacement was closely followed, while much of the granite and hornfelsed Halls Creek Group were still very hot, by intrusions of McIntosh Gabbro. These mafic intrusions locally raised the temperature of the granite and hornfels to well above that at which partial melting of felsic rock could take place. At such localities the mafic magma commingled with the resulting felsic melt, leading to the development of both net-veined complexes and migmatitic Tickalara Metamorphics. Where the mafic magma intruded relatively cool Halls Creek Group, outside the metamorphic aureoles around the Bow River Granite plutons, partial melting did not take place, and non-migmatitic contact hornfels were formed. Hence the Tickalara Metamorphics, as suggested by Gemuts & Smith (1968) and also Gemuts (1971), may be contact metamorphosed, rather than regionally metamorphosed, up to granulite facies. If so, this metamorphism postdates, rather than being synchronous with, the Barramundi Orogeny.

KIMBERLEY GROUP

King Leopold Sandstone

Distribution. Mount Barrett W of Halls Creek township and ridges to east and northeast of township (Gemuts & Smith, 1968).
Thickness. Possibly up to 300 m.
Rock types. Quartz sandstone: medium-grained, medium to thick-bedded, cross-bedded; minor pebbly to conglomeratic beds, pebbles predominantly of vein quartz. :t6
Relationships. Unconformable on Lamboo Complex near Mount Barrett; overlain conformably by Carson Volcanics.
Age. Younger than Whitewater Volcanics (1850 Ma - Page & Hancock, 1989) and older than Hart Dolerite (about 1800 ma - Page, in BMR 1989).
Remarks. The Kimberley Group is a possible correlative of the Reynolds Range Group of the Arunta Block and Hatches Creek Group of the Tennant Creek Inlier (e.g., Blake, 1978; see also Blake, 1991).

Carson Volcanics

Distribution. West side of Mount Barrett and east and northeast of Halls Creek township (Gemuts & Smith, 1968).
Rock types. Epidotic and chloritic amygdaloidal metabasalt; interlayed lithic arenite.
Relationships. Conformable on King Leopold Sandstone.

SUMMARY OF GEOLOGICAL HISTORY (Figure 1)

1910-1870 Ma. Bimodal volcanism and clastic and carbonate sedimentation, represented by the Halls Creek Group. The oldest formation exposed, the bimodal Ding Dong Downs Volcanics, is taken to include Sophie Downs "granite", which may be either subvolcanic or extrusive. This early volcanism was followed by probably fluvial sedimentation represented by the Saunders Creek Formation, a relatively thin unit consisting of detritus largely derived from outside the Kimberley region. Later bimodal volcanism and mainly shallow water sedimentation (Biscay Formation) was succeeded by the deposition of turbidites (Olympio Formation) in probably deeper water.

Around 1870 Ma – Barramundi Orogeny. The Halls Creek Group was deformed and regionally metamorphosed to upper greenschist/lower amphibolite facies during this orogeny. The earliest structures recognised are foliations, S1, developed parallel to bedding and primary layering, and a mineral elongation lineation, L1. Later folding, F2, was about subvertical axial planes trending mainly north-northeast. The main schistosity, S2, in the Halls Creek Group is axial planar to these folds and probably formed during the folding. The Saunders Creek, Sophie Downs, and Prospect Creek Domes are F2 folds.
About 1870 Ma. Molasse-type sedimentation (Moola Bulla Formation) perhaps related to uplift associated with Barramundi Orogeny.
Around 1850 Ma. Emplacement of Bow River Granite plutons; contact metamorphism of adjacent previously deformed and regionally metamorphosed Halls Creek Group.
Around 1850 Ma. Intrusion of McIntosh Gabbro bodies shortly after granite emplacement. Where mafic magma was intruded into still very hot granite and hornfels, some partial melting took place, and mafic magma commingled with the resulting felsic melt, leading to the development of net-veined complexes and migmatitic Tickalara Metamorphics.
Between 1850 and 1800 Ma. Period of subaerial erosion, with eventual unroofing of granite plutons and exposure of mafic intrusions, net-veined complexes and Tickalara Metamorphics, followed by deposition of King Leopold Sandstone and subsequent mafic volcanism (Carson Volcanics).
Post 1800 Ma. Periods of tectonism, causing folding of the Moola Bulla Formation and Kimberley Group and movement along the Halls Creek Fault and other faults.

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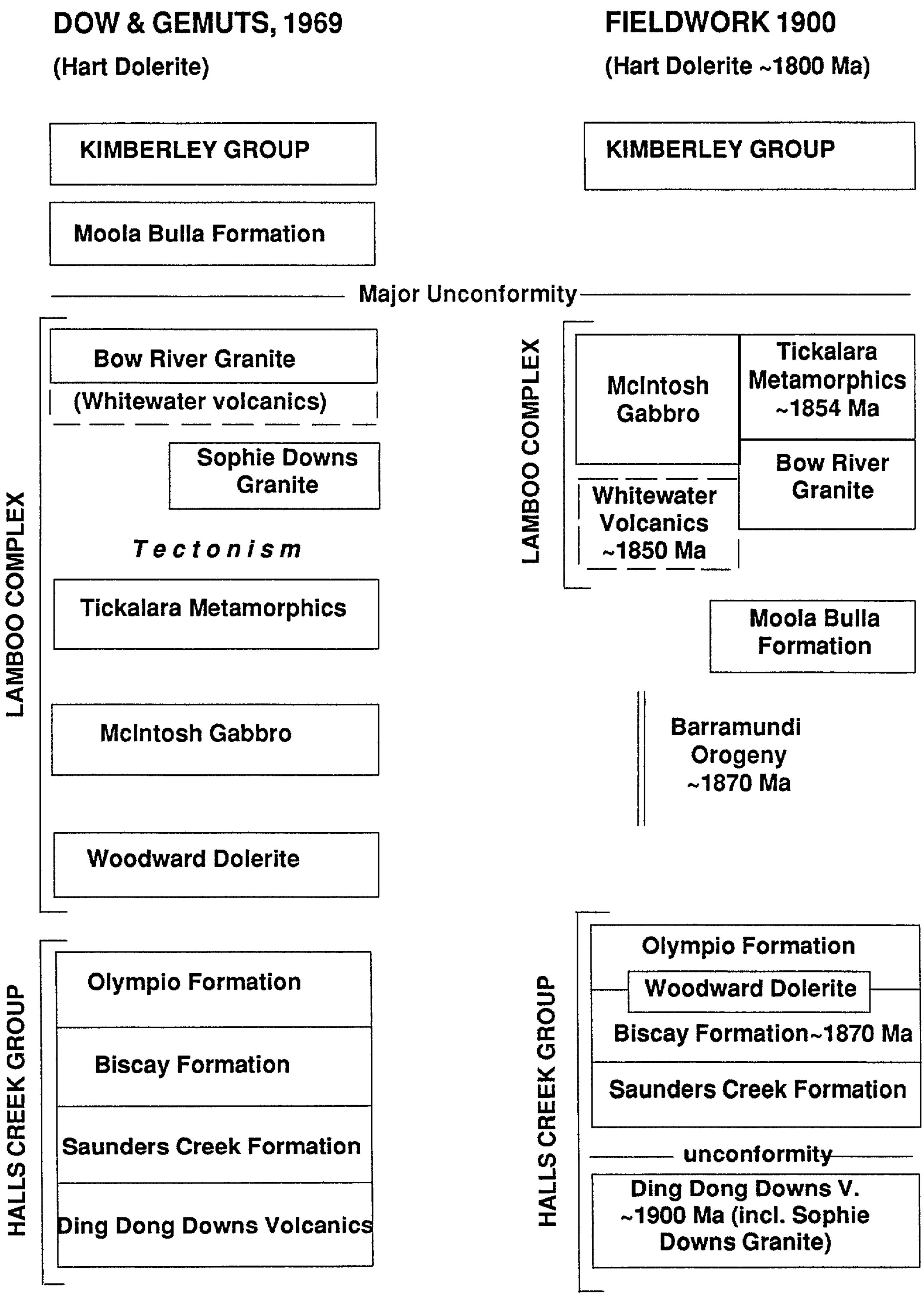

Figure 1. Stratigraphic schemes for the Proterozoic in the area mapped in 1990 in the northern part of the Halls Creek 1:100 000 Sheet, east Kimberley region. Units in parentheses crop out nearby, but not in area mapped in 1990.

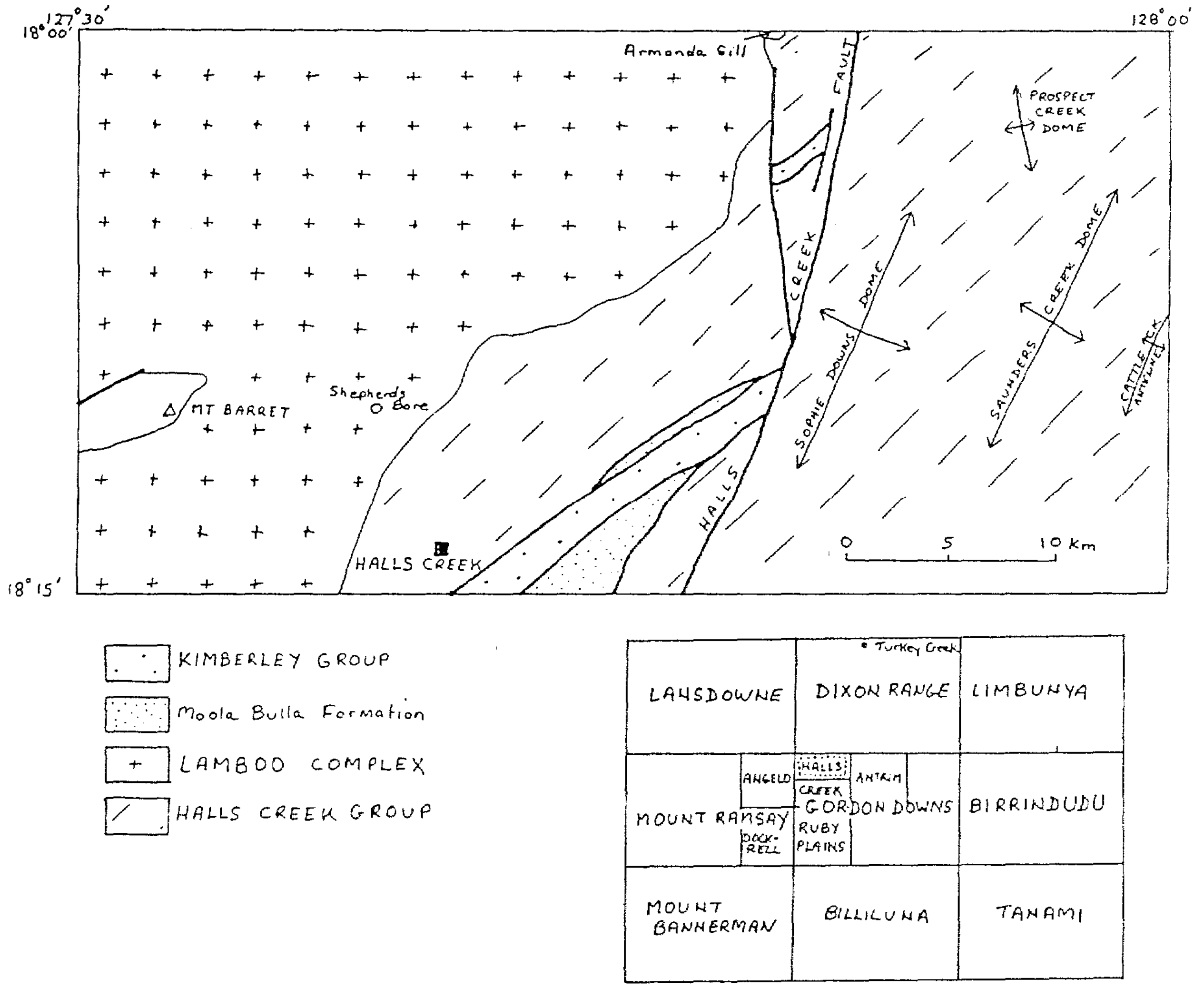

Figure 2. Locality map and generalised geology, northern half of Halls Creek 1:100 000 map area.