Department of Science, Information Technology and Innovation

Flinders River Springs Supergroup

Hydrogeology and ecology

2016

Queensland Government

Prepared by

Queensland Herbarium
Science Delivery Division
Department of Science, Information Technology and Innovation
PO Box 5078
Brisbane QLD 4001

Excerpt from

Fensham, R.J., Silcock, J.L., Laffineur, B., MacDermott, H.J. 2016, Lake Eyre Basin Springs Assessment Project: Hydrogeology, cultural history and biological values of springs in the Barcaldine, Springvale and Flinders River supergroups, Galilee Basin springs and Tertiary springs of western Queensland. Report to Office of Water Science, Department of Science, Information Technology and Innovation, Brisbane.

Citation

Queensland Herbarium 2017, Lake Eyre Basin Springs Assessment Project: Hydrogeology, cultural history and biological values of springs in the Barcaldine, Springvale and Flinders River supergroups, Galilee Basin springs and Tertiary springs of western Queensland. Report to Office of Water Science, Department of Science, Information Technology and Innovation, Brisbane.

Front Cover: Edgbaston Springs and a spring (imaginatively) called “New Big”. There is Spinifex in the foreground, free water in the mid-ground, with some scalding in front and the far right rear. Photo: Queensland Herbarium.

March 2017

Contents

Overview.. 2

Hydrogeology.. 3

Regional geology 3

Hydrology of the springs 3

Biological values.. 11

Outcrop springs 11

Discharge springs 11

References 13

Overview

The outcrop springs of the Flinders River supergroup are typically within the gullies of the Gregory Range (Figure 1) and have been partially surveyed and approximately tallied using likely images from remote sensing (Table 1). These springs have a very different character to the springs of the plains as the water drains out of the rocks under gravity rather than welling upwards under artesian pressure. Some of these springs are large and provide the perennial source for major streams such as the Norman, Clara and Yappar Rivers flowing westward from the ranges and the Gilbert River flowing northward. Only some of these springs have been visited and most are difficult to access. This project has concentrated on compiling information for the 'discharge springs' within the Great Artesian Basin that occur on flat country away from the ranges. Unlike outcrop springs, discharge springs have suffered severely diminished flows (Figure 1) due to reduced aquifer pressure brought about by extensive sinking of bores. Only 20% of the discharge spring wetlands remain active.

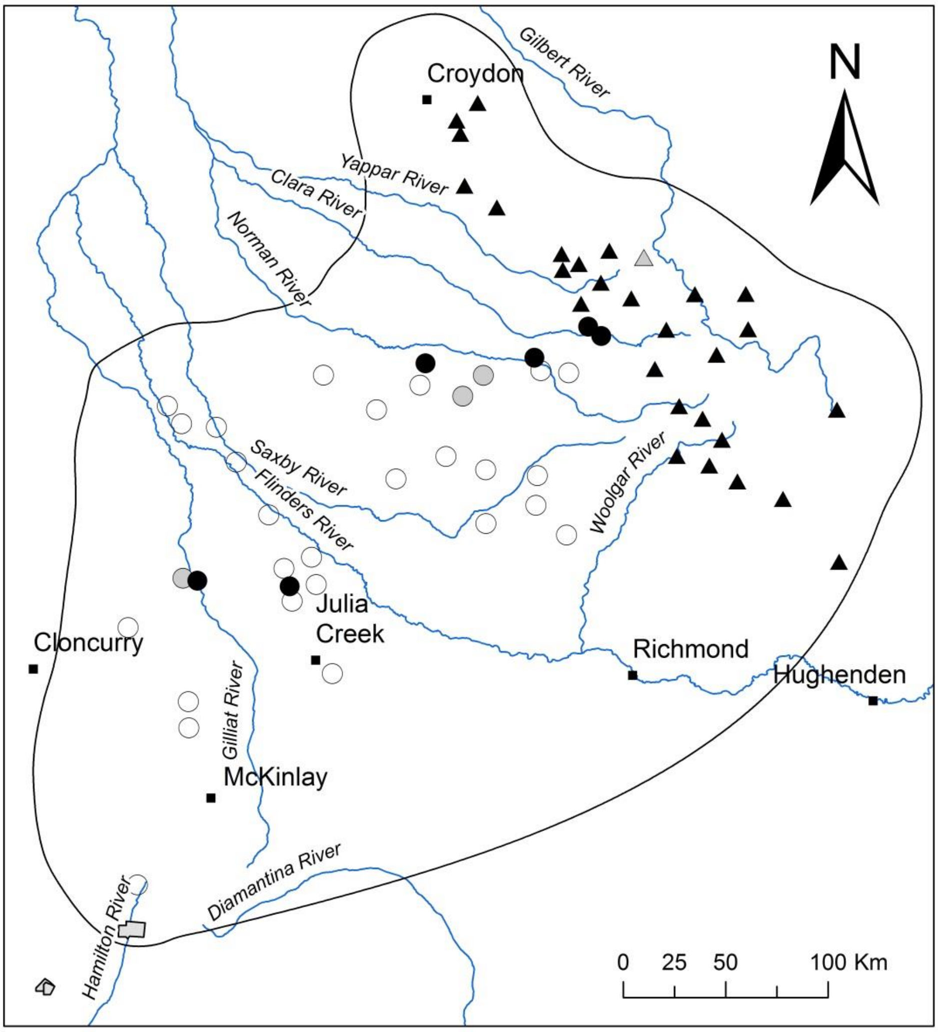

Figure 1. Spring complexes within the Flinders River supergroup. Spring complexes with 100% active springs (solid), partially (1%-99%) active (grey) and 100% inactive (open symbols) are identified. Outcrop springs (triangles) are distinguished from discharge springs (circles). The Cannington Mine is shaded grey in the lower left.

Table 1. Summary of the status of the springs in the Flinders River supergroup at the complex, wetland and vent scale.

	Complex			Wetland		Vent	
	Active	Partially active	Inactive	Active	Inactive	Active	Inactive
Outcrop	27	1	0	91	1	91	1
Discharge	6	3	26	29	118	29	121

Hydrogeology

Regional geology

The Flinders River supergroup spans the Euroka Arch, a basement structure partially separating the Carpentaria Basin from the Eromanga Basin. Granite provides the basement in the northern Eromanga Basin in the southwest of the supergroup and is exposed in a very limited area by the Kevin Downs Fault. The basement of the Carpentaria Basin in the vicinity of the springs is metamorphosed sediments and these Precambrian schists outcrop in the vicinity of springs at Mt Fort Bowen, Mt Brown and Mt Little. The Gilbert River Formation forms the lower unit of the Mesozoic sedimentary sequence and is the main water-bearing aquifer for the springs in this supergroup. Some stratigraphic sequences in bores describe Hooray Sandstone, Cadna-owie Formation and Wyandra Sandstone, but these units are synonymous with facies within the Gilbert River. This sandstone is overlain by a sequence of Cretaceous units, the Wilgunyah Formation, the Toolebuc Member and the Allaru Member that act as aquitards. The Gilbert River Formation outcrops extensively in the eastern part of the Supergroup and there are many large outcrop springs, many of which are isolated in rugged ranges, providing baseflow for major streams including the Woolgar, Norman, Clara and Yappar Rivers.

In addition to the isolated outcrops of granite and metamorphic rocks in the western edges there are important structures relating to springs. A large network of springs is aligned in the vicinity of the Woodstock Structure, a pronounced section of the Euroka Arch. Another structure clearly associated with springs is the north-south trending St Elmo Structure. Tectonic activity that created these structures during the Paleozoic has reactivated to result in minor faulting.

Hydrology of the springs

The springs associated with the outcropping Gilbert River Formation in the eastern region of the supergroup are probably gravity-fed springs fed from higher elevation sandstone. The Gregory Range to the east of these areas is represented by a tableland of Tertiary sands overlying the sandstone. These provide recharge intake beds that store water before it percolates through the sandstone. In the south and centre of the region these springs emanate from stratigraphic weaknesses associated with side-gullies from the main streams (Figure 2). In the northern areas to the south-east of Croydon large springs are associated with the footslopes of the outcropping sandstone but not necessarily in association with gullies.

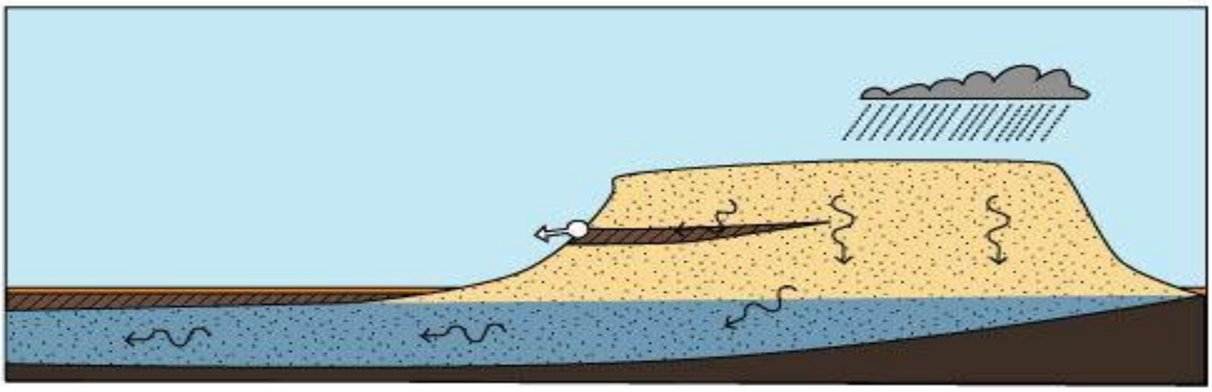

Figure 2. Conceptual diagram representing the outcrop springs in the outcropping Gilbert River Formation. The brown wedge may represent a confining layer in the sandstone or a fracture aligned with the stratigraphy.

The discharge springs associated with the Woodstock Structure (Pelham, East Creek and nearby properties) are not aligned in a linear arrangement suggesting that they may be associated with polygonal fault structures (Stratigraphy A, Figure 3). The springs on Bunda Bunda, Saxby Downs and nearby properties to the south may also be associated with polygonal faulting (Stratigraphy C, Figure 3). There is no obvious evidence of faulting in the stratigraphy represented by bore logs for either of these spring clusters (Figure 4, Figure 6).

These faults may be only relatively weak but the substantial artesian pressures in this region (probably up to 80m head), some of the highest in the GAB, were sufficient to result in surface discharge through springs. This artesian head has diminished after more than a century of discharge through large bores throughout the region, and the network of springs currently includes active springs, inactive springs and springs that were previously permanent, but are now only ephemeral. These ephemeral springs often occur in local sinkholes (Figure 6), but do not have obvious vents suggesting that their current groundwater source is diffuse discharge from the regolith. Presumably the groundwater source from the Wyandra Sandstone Member/Hooray Sandstone/Gilbert River Formation is supplementing local aquifers in the overlying Cainozoic deposits.

When these surface aquifers are diminished during long dry periods discharge through faults in the underlying aquitard soaks up into the regolith and the groundwater does not discharge at the surface. When the surface aquifer in the regolith is replenished by rainfall, groundwater diffuses to the surface in the hollows of former permanent springs. When aquifer pressure was higher before groundwater exploitation through bores, some of these now ephemeral springs would have been permanent, while others were probably always ephemeral.

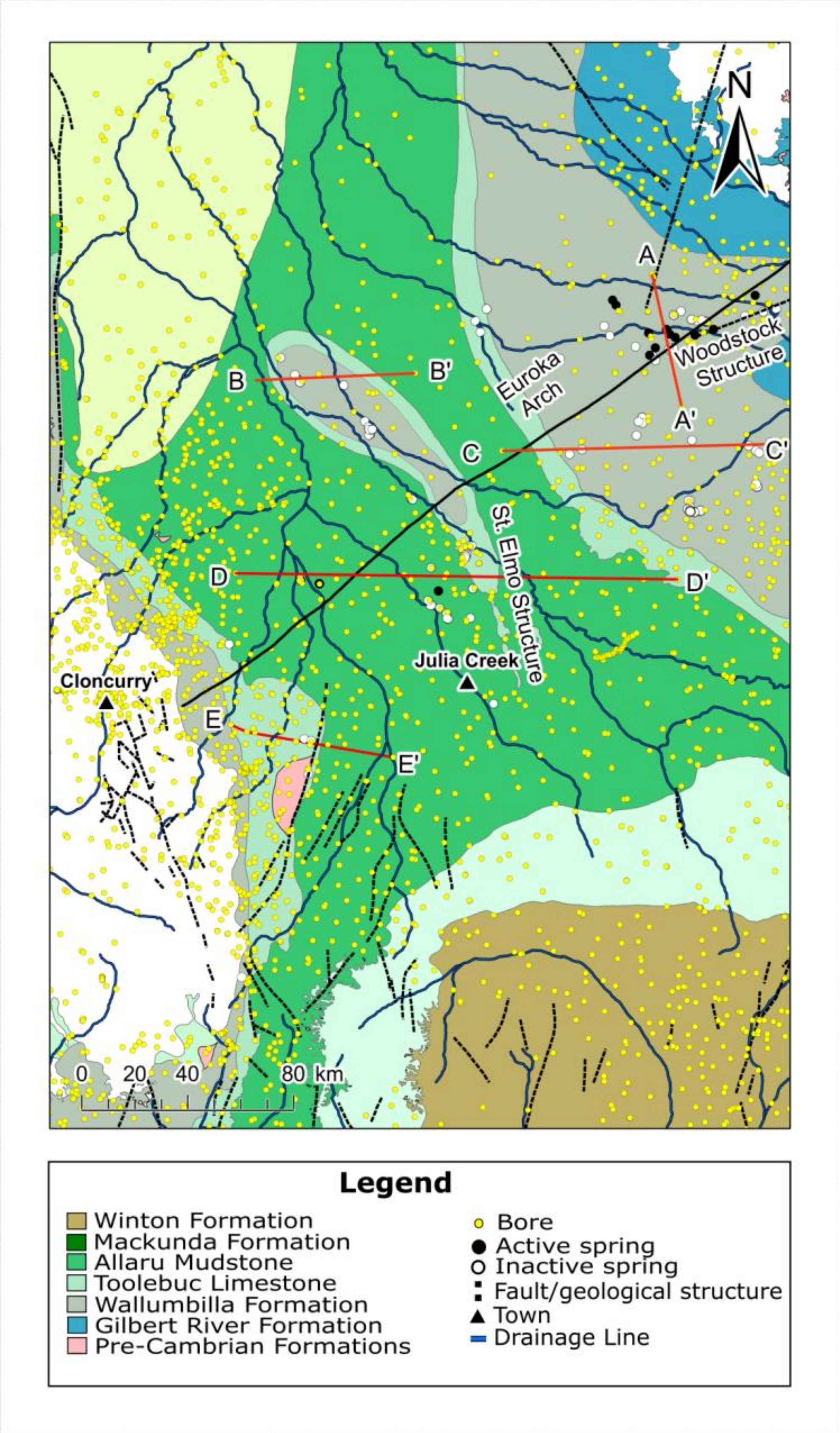

Figure 3. Discharge springs in the Flinders River supergroup and the associated surface geology with some important structural features identified. The position of the stratigraphic lines represented below is indicated.

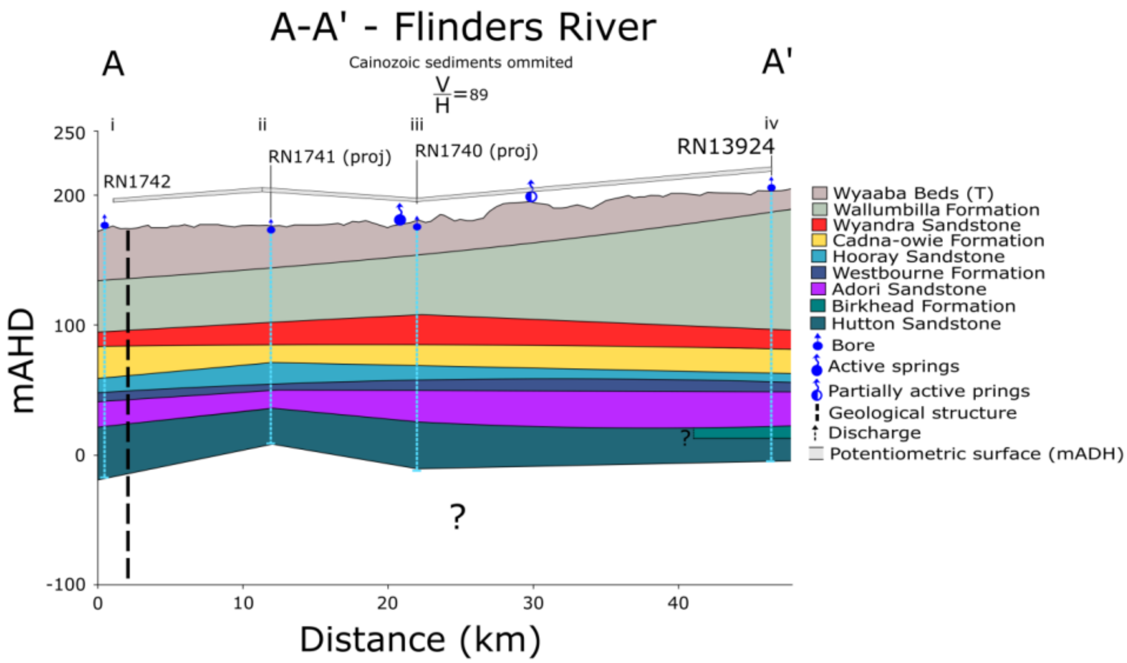

Figure 4. Stratigraphy through Flinders River discharge springs (see A-A'; Figure 3 for location). Where bores are projected onto the stratigraphic line the difference in elevation is indicated by the position of the bore symbol in relation to the ground surface. The range in the potentiometric head over time is represented by the limits of the grey bar and the roman numerals indicate the location of the bores that inform the head. i: RN92941, min. date 1998: SWL 19.12, max.date 2001: SWL 22.16; ii: RN92941, min. date 1995: SWL 30.4, max.date 2002: SWL 33.6; iii: RN92411, min. date 1995: SWL 30.4, max.date 2002: SWL 33.6; RN69661, min. date 1992: SWL 32, max.date 1999: SWL 35.4; iv: RN13924, min. date 1989: SWL 15, max.date 2011: SWL 18.6.

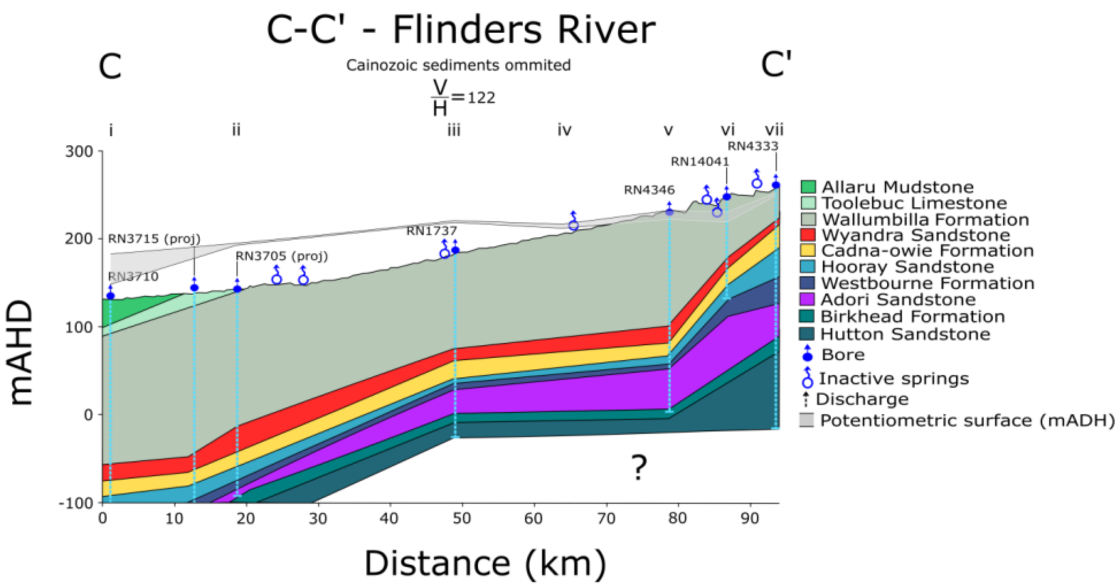

Figure 5. Stratigraphy through Flinders River discharge springs (see C-C'; Figure 34 for location). Where bores are projected onto the stratigraphic line the difference in elevation is indicated by the position of the bore symbol in relation to the ground surface. The range in the potentiometric head over time is represented by the limits of the grey bar and the roman numerals indicate the location of the bores that inform the head. i: RN3710, min. date 1968: SWL 16.9, max.date 1902: SWL 51; ii: RN93497, min. date 1998: SWL 47.62, max.date 2002: SWL 50.68; iii: RN93366, min. date 1996: SWL 33.78, max.date 1999: SWL 36.57; iv: RN14155, min. date 1991: SWL 9.6, max.date 2011: SWL 15.41; v: RN4346, min. date 1971: SWL -5.39, max.date 1915: SWL 4.18; vi: RN14041, min. date 1968: SWL - 14.3, max.date 2011: SWL - 25.6; vii: RN4333, min. date 1901: SWL -9.14, max.date 1912: SWL -5.79.

Figure 6. Savannah Run 1 Spring. These sinkhole shaped features no longer flow permanently. Some of them such as the Savannah Run Springs on Bunda Bunda are used as cattle watering points and are supplemented by bore water.

When the regolith includes fine-grained dispersive silt, springs can form mud mounds. Mud-springs can be flat or mounded but form where the groundwater has mixed with fine sediment to form a slurry emanating from the spring vent. The slurry may not flow to the surface for long periods and dry surface layers can form a ‘skin’ over the soupy interior material. Occasionally the groundwater-mud slurry spews to the surface in a burst of activity. At Cooradine there are mud springs that have had a relatively temporary existence, appearing in a location, exhibiting a fit of activity and then drying up and deflating leaving a sunken hollow (Figure 7). This cycle can occur within the space of a decade (Patrick Hick pers. comm.). Many of the mud springs in the Julia Creek area have become inactive.

There are also springs associated with outcropping basement rocks. The best examples of these are at Mt Fort Bowen, Mt Brown and Mt Little. There is little evidence of the sediments rising toward the surface as they onlap to the metamorphic cones (Figure 8). It seems that the contact between the sediments and basement blocks is sufficient to provide an effective conduit for groundwater discharge. However, many of these springs have become extinct despite positive artesian pressure in this area (Figure 8). One of the springs in the vicinity of Mt Brown was a rare example of a hot spring within the GAB, and the temperature was estimated at 49°C (Palmer 1884). The source of the heat was probably a result of the natural geothermal gradient with depth. There are also minor springs associated with outcropping granite in the vicinity of Kevin Downs but these springs are now extinct.

Figure 7. Active mud spring at Cooradine in 2012 (above) and an inactive deflation hollow (below) formed by a collapsed mud spring.

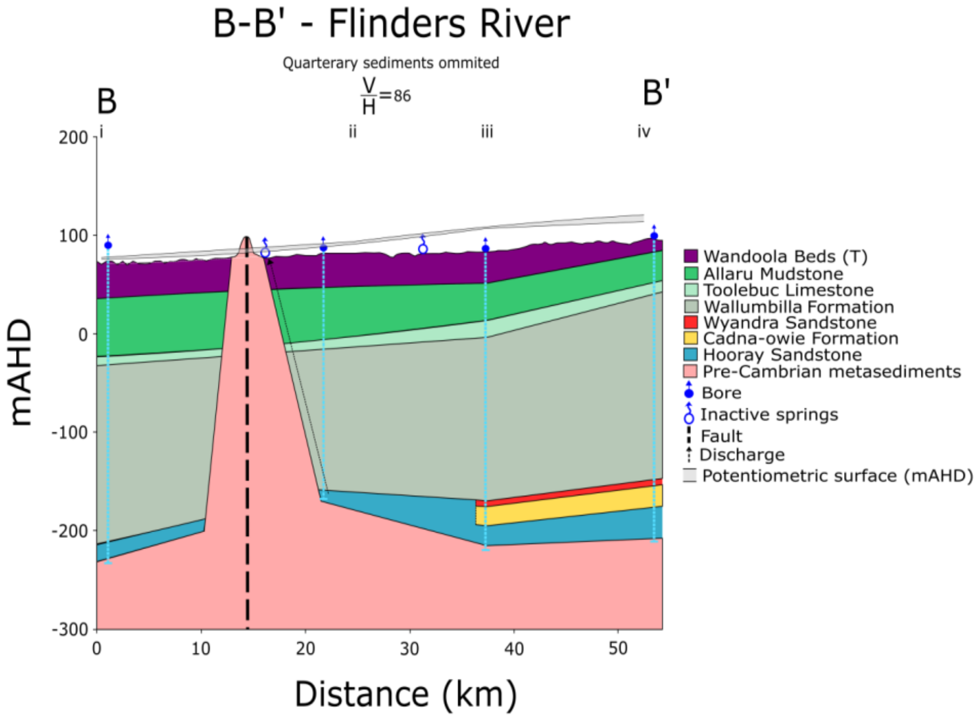

Figure 8. Stratigraphy through Flinders River discharge springs (see B-B'; Figure 34 for location). Where bores are projected onto the stratigraphic line the difference in elevation is indicated by the position of the bore symbol in relation to the ground surface. The range in the potentiometric head over time is represented by the limits of the grey bar and the roman numerals indicate the location of the bores that inform the head. i: RN1949, min. date 1969: SWL -2.29, max.date 1947: SWL -0.61; ii: RN31843, min. date 1973: SWL 6.3, max.date 1988: SWL 8.4; iii: RN14615, min. date 1973: SWL 21.13, max.date 2000: SWL 22.5; iv: RN15425, min. date 2005: SWL 22.4, max.date 2011: SWL 30.7.

Other springs are associated with faulting associated with the western side of the St Elmo Structure. In this stratigraphy generated from bore logs the potential displacement of these fault structures is as much as 100m (Figure 9). Many of the bores are inactive despite positive, but greatly diminished artesian pressure (Figure 9).

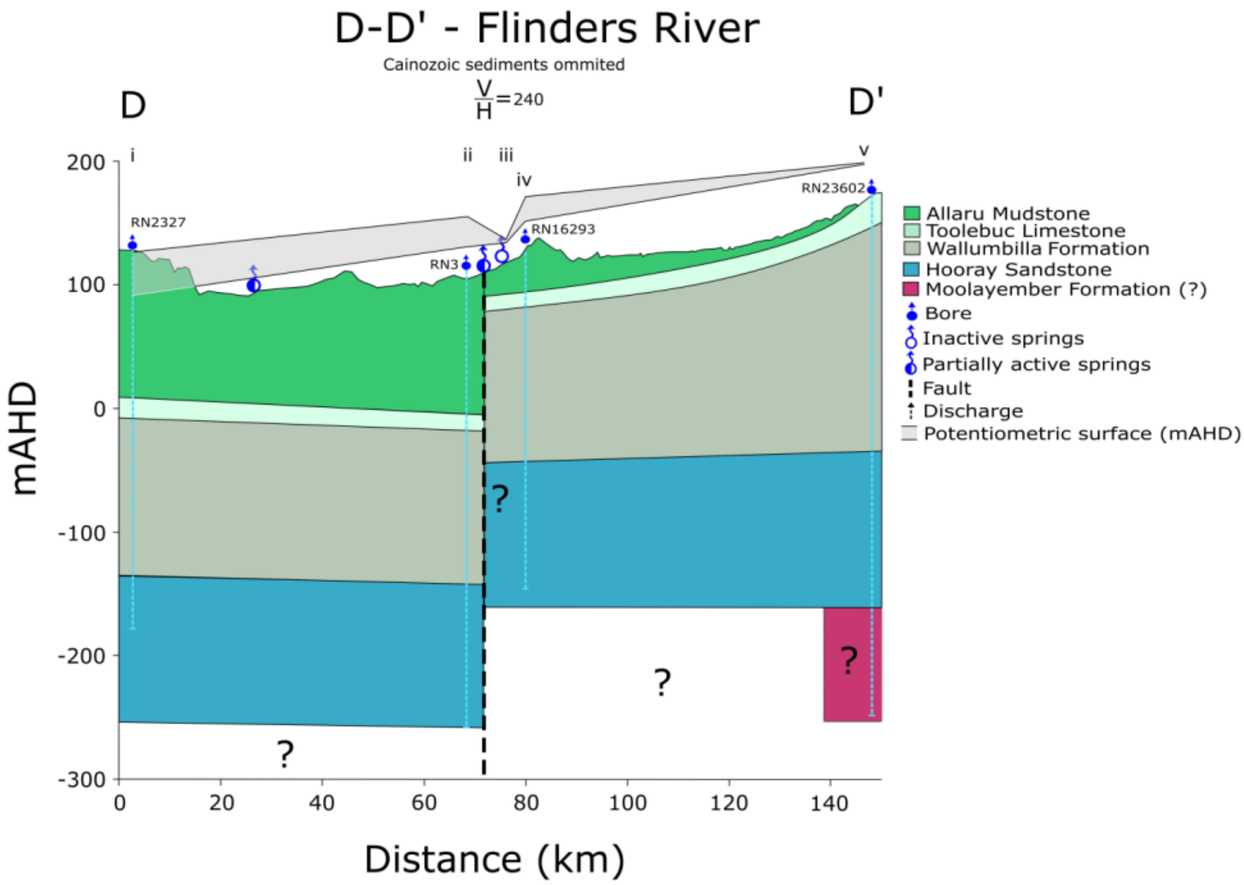

Figure 9. Stratigraphy through Flinders River discharge springs (see D-D'; Figure 34 for location). Where bores are projected onto the stratigraphic line the difference in elevation is indicated by the position of the bore symbol in relation to the ground surface. The range in the potentiometric head over time is represented by the limits of the grey bar and the roman numerals indicate the location of the bores that inform the head. i: RN2327, min. date 1970 : SWL - 36.58, max.date: 1967: SWL -1.83; ii: RN3, min. date 1989 : SWL 17.7, max.date: 1922: SWL 42.67; iii: RN93868, min. date 2002 : SWL 15.82, max.date: 2002: SWL 19.02; iv: RN9166, min. date 1943 : SWL 16.9, max.date: 1943: SWL 36.62; v: RN93412, min. date 1997 : SWL 9.1, max.date: 1998: SWL 9.9.

Two inactive springs, Box Creek and Leilavale (yet to be located on the ground) straddle the Kevin Downs Fault, where there is currently insufficient potentiometric head for artesian discharge (Figure 10).

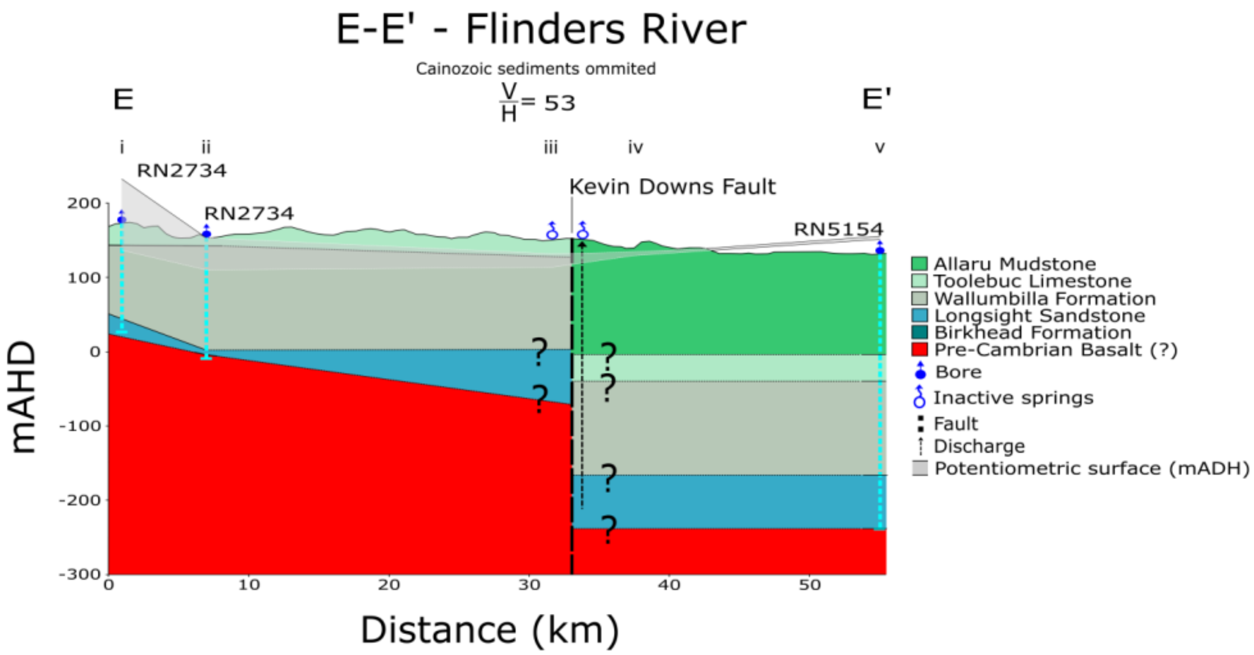

Figure 10. Stratigraphy through Flinders River discharge springs (see E-E'; Figure 3 for location). Where bores are projected onto the stratigraphic line the difference in elevation is indicated by the position of the bore symbol in relation to the ground surface. The range in the potentiometric head over time is represented by the limits of the grey bar and the roman numerals indicate the location of the bores that inform the head. i: RN2755, min. date 1955: SWL -12.2 , max.date 1896 : SWL 57; ii: RN2731, min. date 1967: SWL -42.67 , max.date 1915 : SWL -0.09; iii: RN2463, min. date 1937: SWL – 36.58 , max.date 1937 : SWL -18.29; iv: RN2450, min. date 1967 : SWL -7.32, max.date 1937: SWL -2.74; v: RN14339, min. date 1993: SWL 18 , max.date 2011 : SWL 22.6.

Biological values

Outcrop springs

The large springs associated with outcropping sandstone in side gullies of the Gregory Range are typically dominated by large paperbark trees (*Melaleuca leucadendra*) with an understorey of sedges (e.g. *Baumea rubiginosa* and *Fimbristylis nutans)* and grasses (e.g. *Ischaemum australe*). Some rare species associated with these springs include *Adenostemma lavenia* and *Fimbristylis blakei*, while the tree ferns *Cyathea cooperi* in the spring-fed gullies of the Gregory Range represent highly disjunct populations. *Fimbristylis blakei* is endemic to spring wetlands. There are no endemic invertebrates associated with these relatively acid waters. These low levels of endemism are typical of outcrop springs throughout the GAB (Fensham et al., 2011).

Discharge springs

In contrast, GAB discharge springs in the Barcaldine, Springvale (see this report, sections 3.5.2 and 5.5), Eulo, Bourke (Silcock et al., 2013) and Dalhousie, Lake Frome and Lake Eyre supergroups (Worthington-Wilmer et al., 2008; Fensham et al., 2010; Murphy et al., 2012) are home to endemic plant, fish and invertebrate populations. However, the discharge springs of the Flinders River group either did not support or have not retained specialised organisms. The populations of *Pandanus spiralis* are a distinctive feature of the springs, but this species also occurs along some rivers and also occasionally on inland dunes. The large peaty acid springs on Pelham such as Black and Tucketts provide habitat for the sedge *Fimbristylis complanata,* which appears to be relatively restricted in northern Australia. There are no endemic invertebrates or fish. However, the springs in the region have greatly reduced flow rates and often high degrees of modification through excavation and draining of mounds and there may have been substantial extinction, including of specialised organisms that will never be known.

The extraordinary endemism of discharge springs is typically associated with shallow-water alkaline wetlands, with their distinctive habitat structure and water chemistry (Fensham et al., 2011). Examples of such wetlands are preserved at the three remaining active springs in the southern Flinders River supergroup: Dalgonally, Gilliat Bore and Bauhinia Downs (Figure 11). *Cyperus laevigatus,* a widespread sedge often associated with other endemics, is dominant in these wetlands. This could indicate that endemics were always absent from the Flinders River supergroup.

However, the early descriptions and specimens of Edward Palmer suggest otherwise. Palmer describes vegetated wetlands at both Fort Bowen and Mt Browne. His 1884 plant collections for now-extinct springs at Mt Fort Bowen includes discharge spring signature species *Cenchrus purpurescens* and *Scheonus falcatus*, as well as a record of an *Eragrostis* species which may be spring endemic *Eragrostis fenshamii*. Palmer's observations of spring vegetation at Fort Bowen and Mt Browne are corroborated by Meston (1923, p. 14), who wrote that 'the ground [surrounding the spring vents] is hollow and treacherous, the surface matted together by dense vegetation'. Palmer (1884a) also noted the presence of small fish to six inches long in a spring, probably the vanished Manfred Station springs. This observation was made well before gambusia (*Gambusia holbrookii*), which now dominate many springs wetlands, were introduced to Australia, and these fish may have been spring endemics.

Palmer's record is sufficient to be certain that there has been considerable local extinction of spring dependent wetland species, and suggests that there may have been springs in the Flinders River supergroup that contained endemic species. While it is unlikely that mud springs ever contained endemics, the large alkaline water-springs described by Griffiths such as Lara, Waddy, Gorge, Berinda, Manfred Station and Mazeppa may once have contained specialised flora and fauna, which will never be known. Groundwater scald indicator species *Sporobolus partimpatens* and *Trianthema* sp. (Coorabulka R.W. Purdie 1404) are present at some sites, including extinct springs.

Figure 11. Dalgonally (top left), Gilliat Bore (top right) and Bauhinia springs (bottom) are the only shallow-water alkaline discharge springs remaining active in the Flinders River supergroup.

References

Fensham, R.J., Ponder, W.F. & Fairfax, R.J. (2010) Recovery plan for the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin. Department of the Environment, Water, Heritage and the Arts, Canberra. Queensland Department of Environment and Resource Management, Brisbane.

Fensham, R.J., Silcock, J.L., Kerezsy, A. & Ponder, W. (2011) Four desert waters: Setting arid zone wetland conservation priorities through understanding patterns of endemism. Biological Conservation, 144**,** 2459-2467.

Meston, A. (1923) Lakes, mineral springs, and artesian bores. 28 April 1923. 28 April 1923.

Murphy, N.P., Breed, M.F., Guzik, M.T., Cooper, S.J.B. & Austin, A.D. (2012) Trapped in desert springs: phylogeography of Australian desert spring snails. Journal of Biogeography, 39**,** 1573-1582.

Silcock, J., Powell, O., Drimer, J. & Fensham, R. (2013) Ecological and hydrogeological survey of the Great Artesian Basin Springs - Springsure, Eulo, Bourke and Bogan River supergroups - Volume 1: history, ecology and hydrogeology. Report commissioned by the Department of the Environment on the advice of the Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining.,

Worthington-Wilmer, J.W., Elkin, C., Wilcox, C., Murray, L., Niejalke, D. & Possingham, H. (2008) The influence of multiple dispersal mechanisms and landscape structure on population clustering and connectivity in fragmented artesian spring snail populations. Molecular Ecology Notes, 17**,** 3733-3751.