Water Holes and Bush Tucker (Eileen Bloomfield Perrule – Ltyentye Apurte, Central Australia)

Granite Rock Pools as Rare Wetlands

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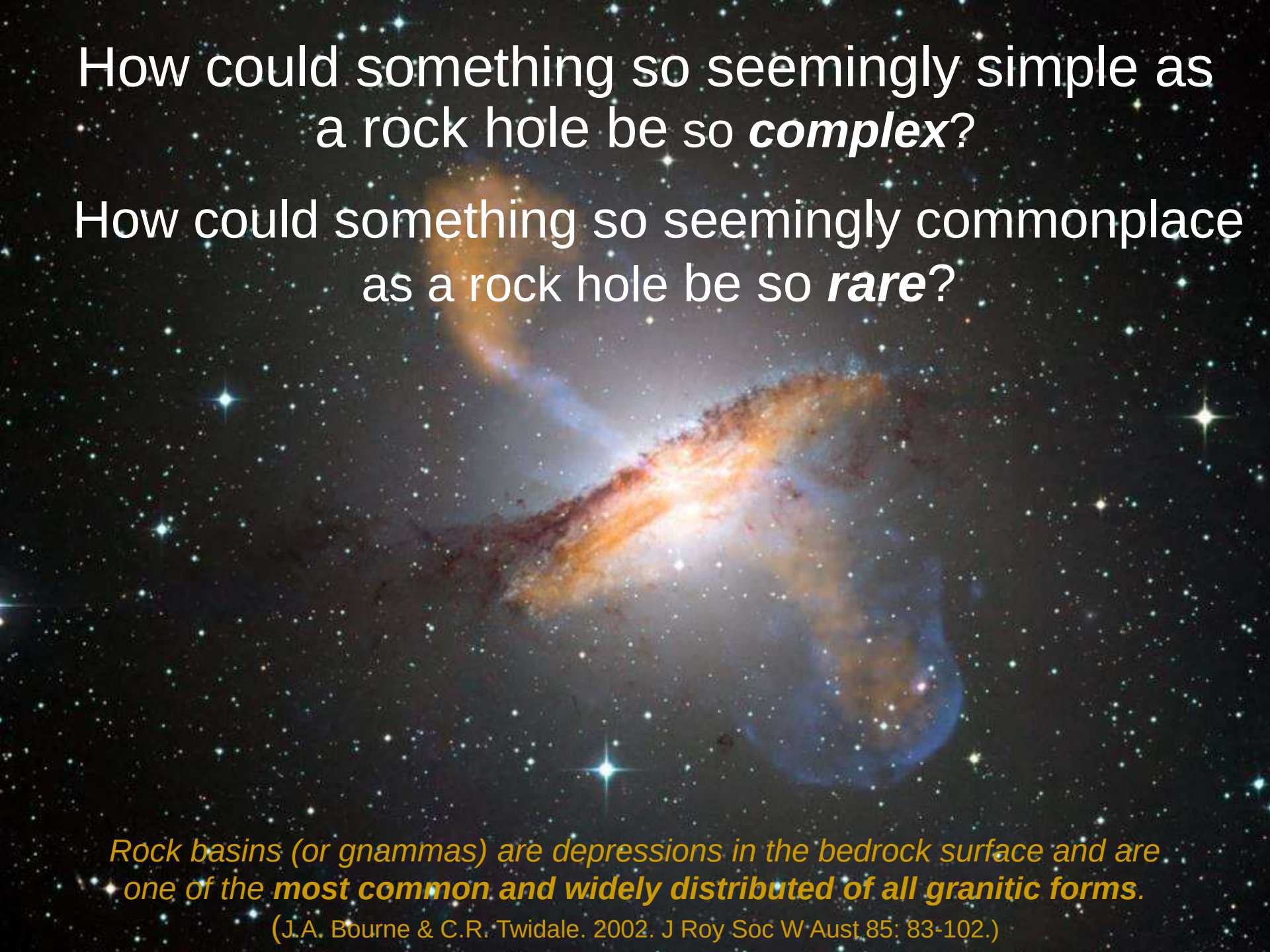
The University of Western
Australia
Albany, WA

How could something so seemingly simple as a rock hole be so ***complex***?

How could something so seemingly commonplace as a rock hole be so ***rare***?



*Rock basins (or gnammas) are depressions in the bedrock surface and are one of the **most common and widely distributed of all granitic forms**.*

(J.A. Bourne & C.R. Twidale. 2002. J Roy Soc W Aust 85: 83-102.)

Gnamma

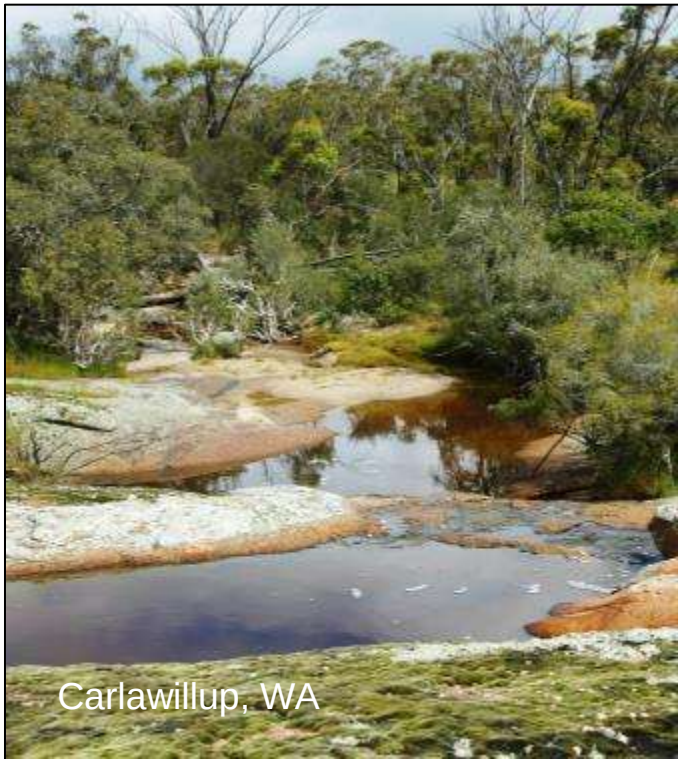
- Rock pool, water hole, rock basin, weather pit, *tinaja*, *aguaje*, galt, vernal pool, etc.
- 'Minor' land form initiated (a) at weathering front, (b) at surface, (c) due to gravitational pressure (Campbell 1997, Withers 2000)

- Western Desert Aboriginal term now used globally in the description of waters, wetlands, or waters/wetlands mosaics in isolated rock formations (e.g., inselberg, monadnock, bornhardt)

Wetlands

"areas of seasonally, intermittently, or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh or saline, e.g., waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries" **(Australian Wetlands Advisory Committee 1977)**

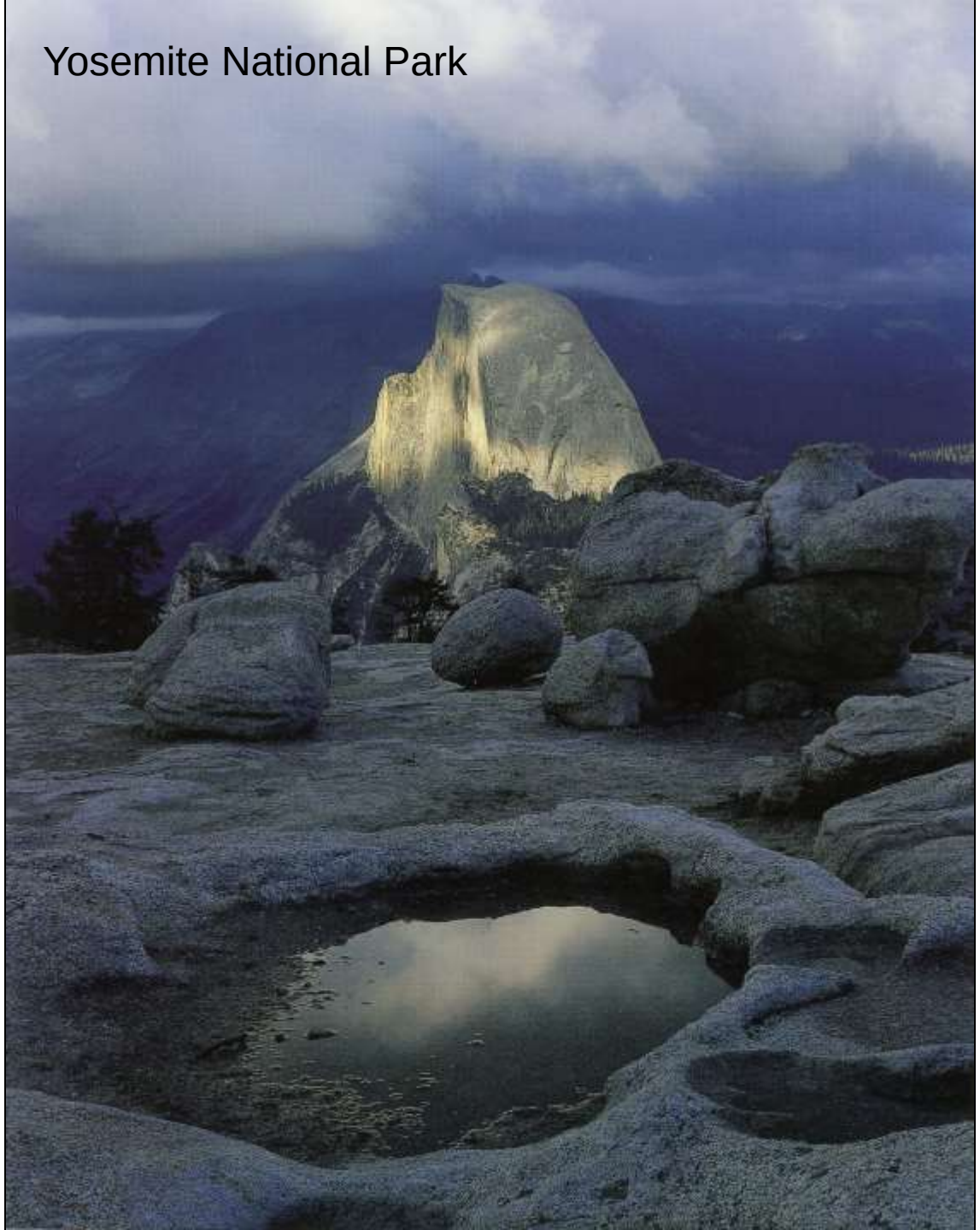
- Hydrology
- Chemistry
- Geomorphology



Carlawillup, WA

Granite Rock Pool Examples

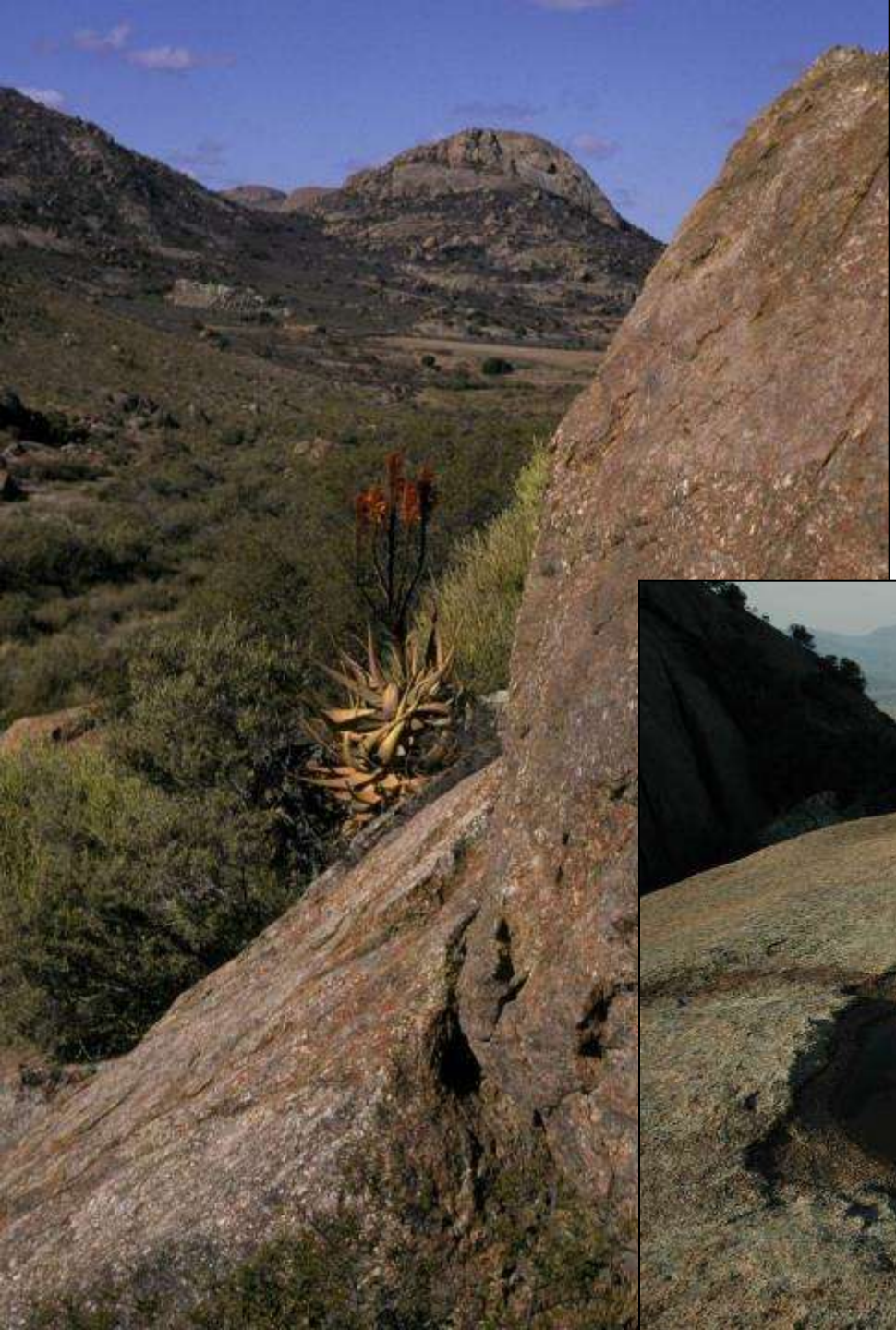
Sweeny Granite Mountains Desert Research Center

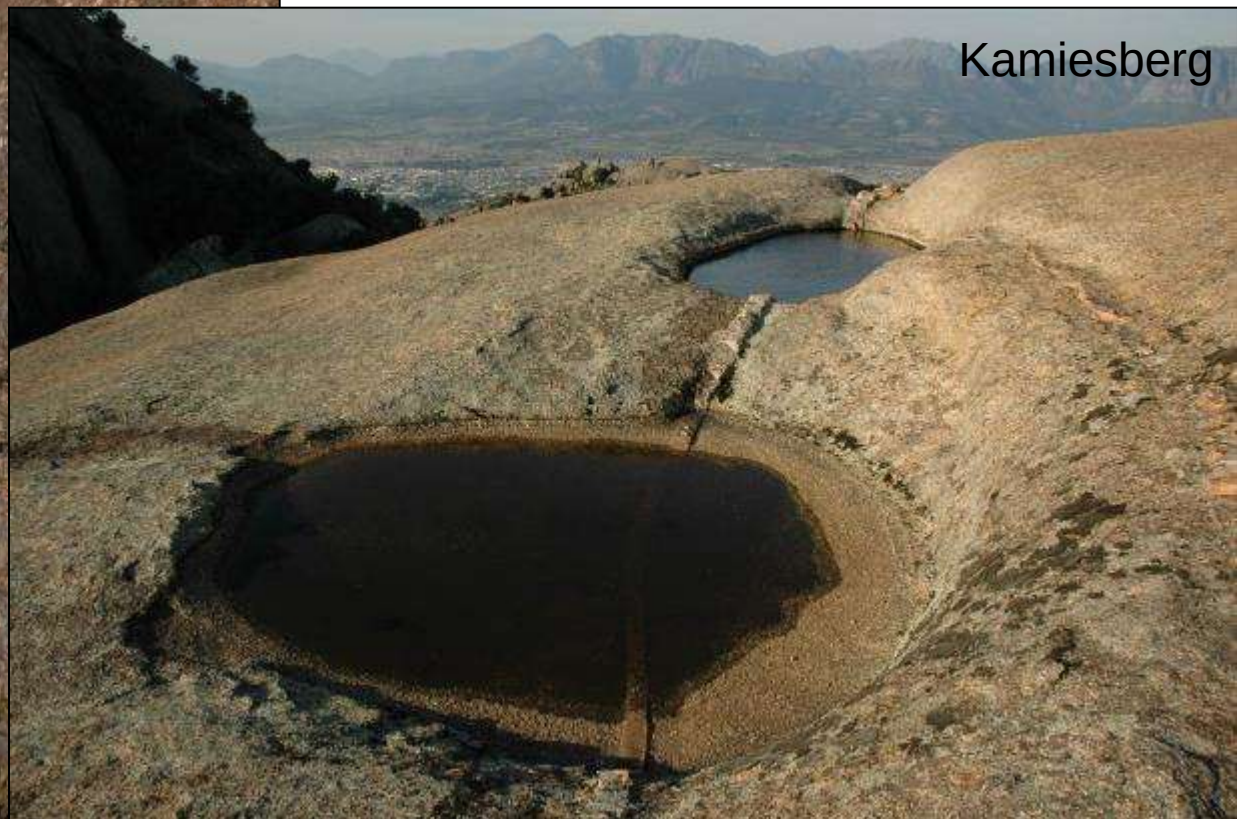

Yosemite National Park

Corsica

Sierra de Guadarrama, Spain

Cape Floristic Region South Africa



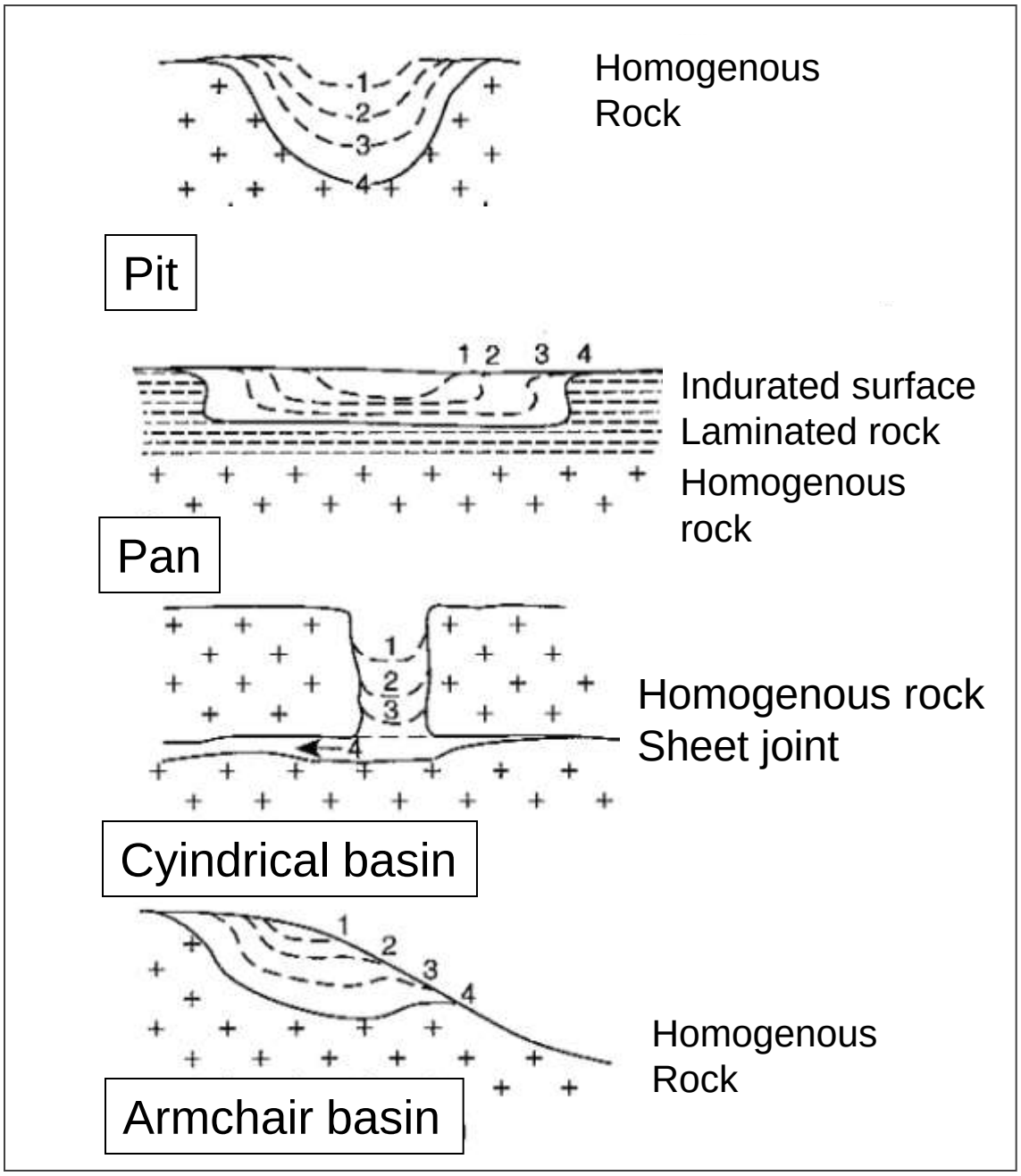


Kamiesberg


Southwest Australia
Floristic Region
Marbaleerup

Development of gnamma types

Timms, B. 2013. Geomorphology of pit gnammas in southwest Australia. *J. Roy. Soc. W. Aust.* 96:7-16.



(Figure 7 from E.M. Campbell. 1997. Granite landforms. *J. Roy. Soc. W. Aust.* 80:101-112.)

Step 1: Initiation of depression

- insolation ⇨ flaking
- crystalline irregularities
- lichen
- subaerial weathering (acids)

Step 2: Break-up of rock

- further insolation
- wind
- moving water
- glacial ice
- wetting/drying cycles

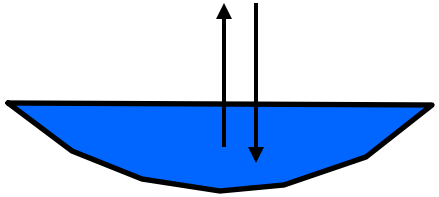
Step 3: Removal of weathered material

- wind
- in solution
- humans

Generalized Types of Depressional Wetlands

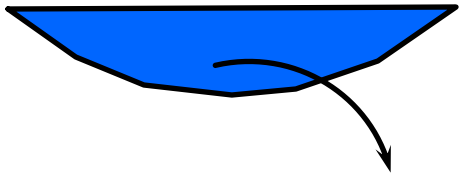
(*hydrologically speaking…*)

Perched



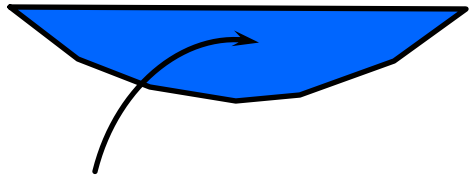
(many gnammas)

Recharge



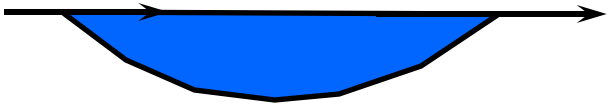
(some gnammas)

Discharge



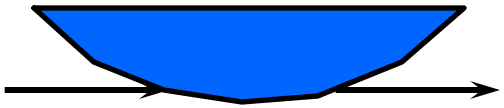
(a very few gnammas)

Flow-Through



Surface

(many gnammas)



Sub-surface

(a very few gnammas)

Pan Gnammas


Cape of Good Hope, SA


Yosemite, CA


Wave Rock, WA


Granite Mountains, CA

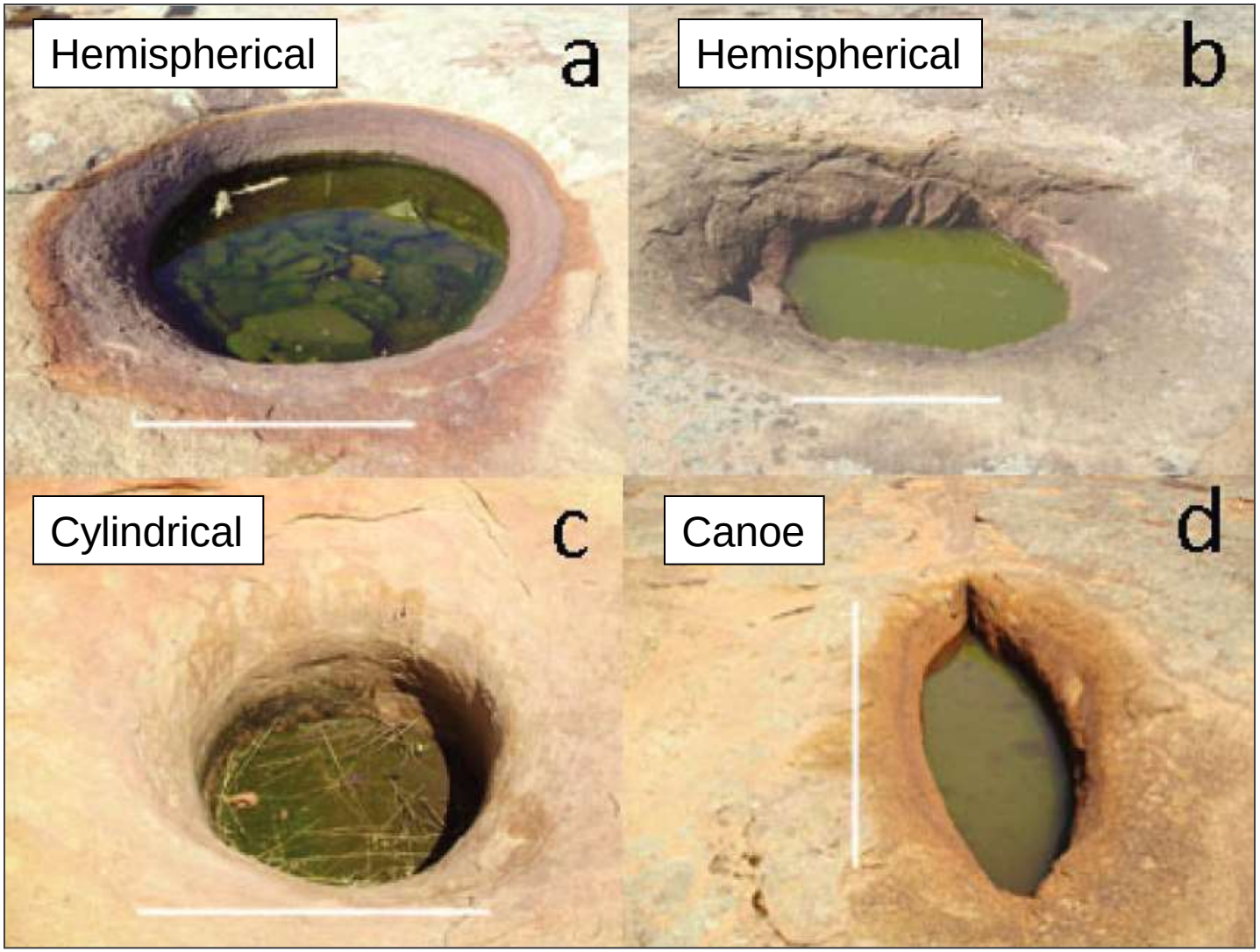
Pit GnammaTypes

Table 1 *from*Timms, B. 2013. Geomorphology of pit gnammas in southwest Australia. *J. Roy. Soc. W. Aust.* 96:7-16.

Type	Name	Description	Frequency (%)
1a	Hemispherical	Hemispheric, no microlayering or joint control	21.25
1b	Hemispherical	Hemispheric, w/ layering and/or minor joint influence	30.00
2	Cylindrical	Cylindric – dominant vertical solution	11.25
3	Canoe	Elongate – major joint control	17.50
4	Trough	Positioned along major joint btw 2 rock blocks	5.00
5a	Underground shelf	Expanded depthwise at lower horizontal joint	2.50
5b	Flask	Expanded depthwise in homogenous rock	1.25
6	Lotic pothole	Evorsion trench along waterway	5.00
7a	Plunge pool	Active plunge pool on water course	5.00
7b	Plunge pool	Quiescent plunge pool along water course	1.25

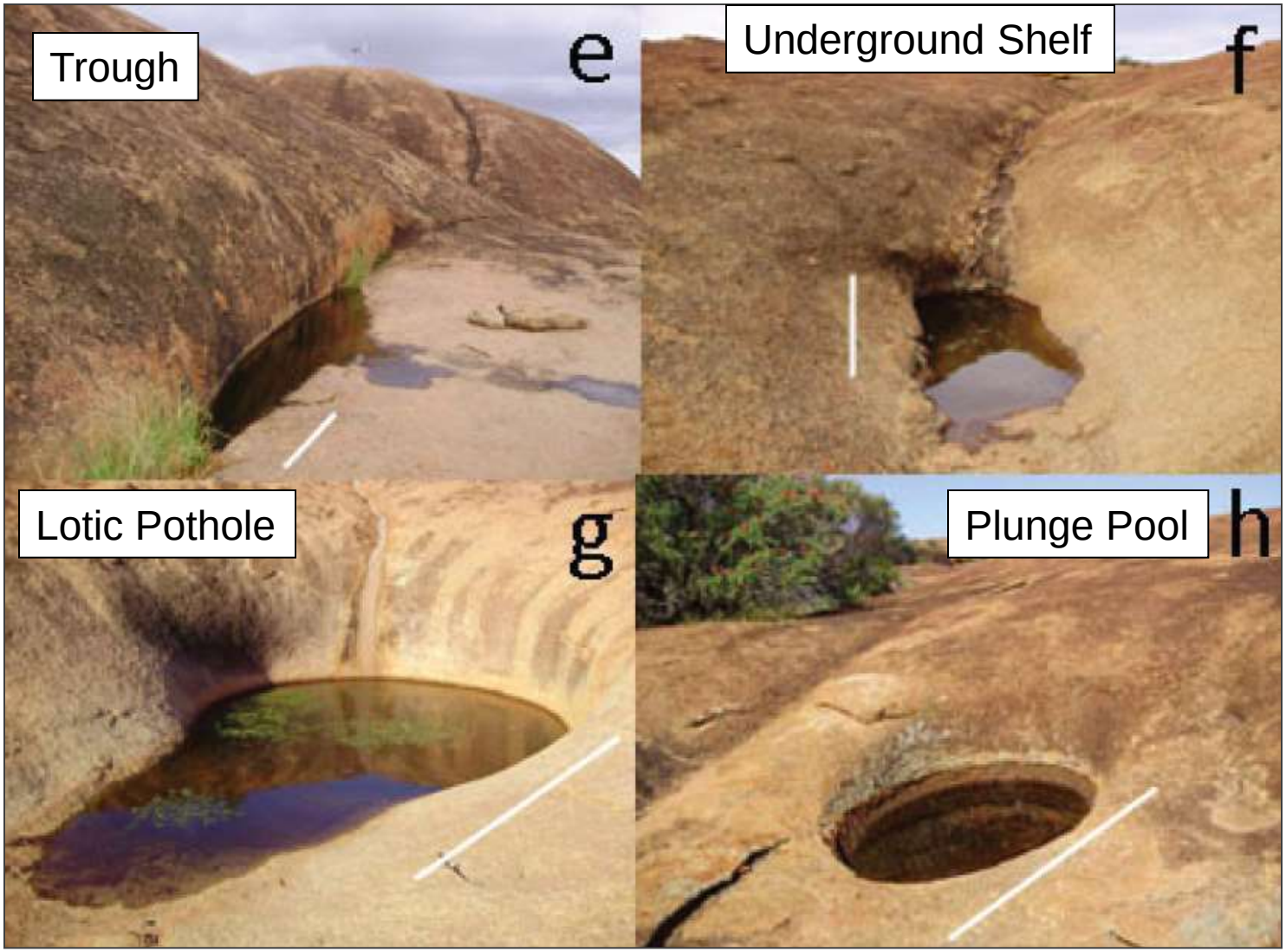
Pit GnammaTypes (1)

(Depth:diameter >0.2)



Timms, B. 2013. Geomorphology of pit gnammas in southwest Australia.*J. Roy. Soc. W. Aust.* 96:7-16.

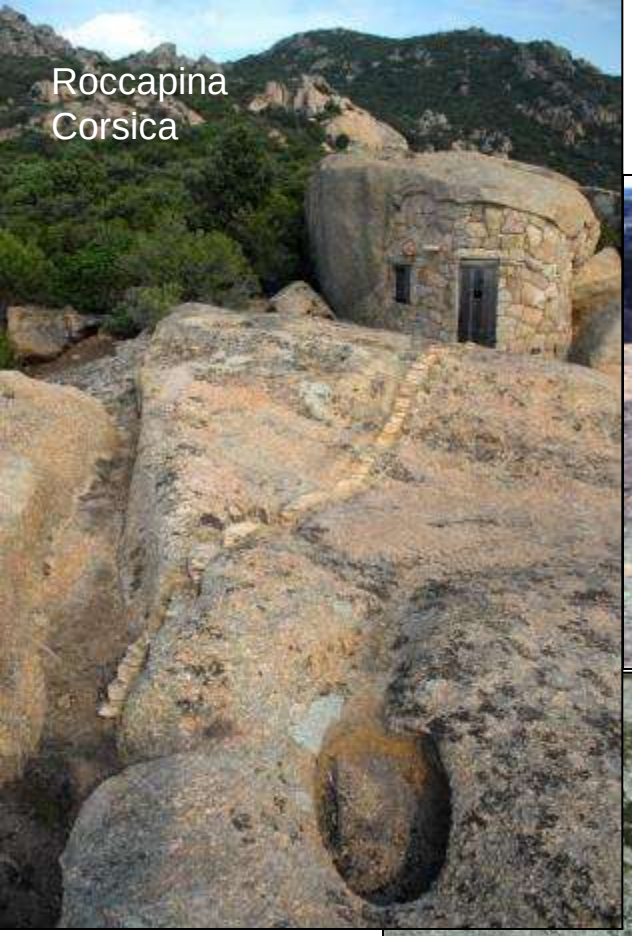
Pit Gnamma Types (2)



Timms, B. 2013. Geomorphology of pit gnammas in southwest Australia.*J. Roy. Soc. W. Aust.* 96:7-16.

Armchair Gnammas

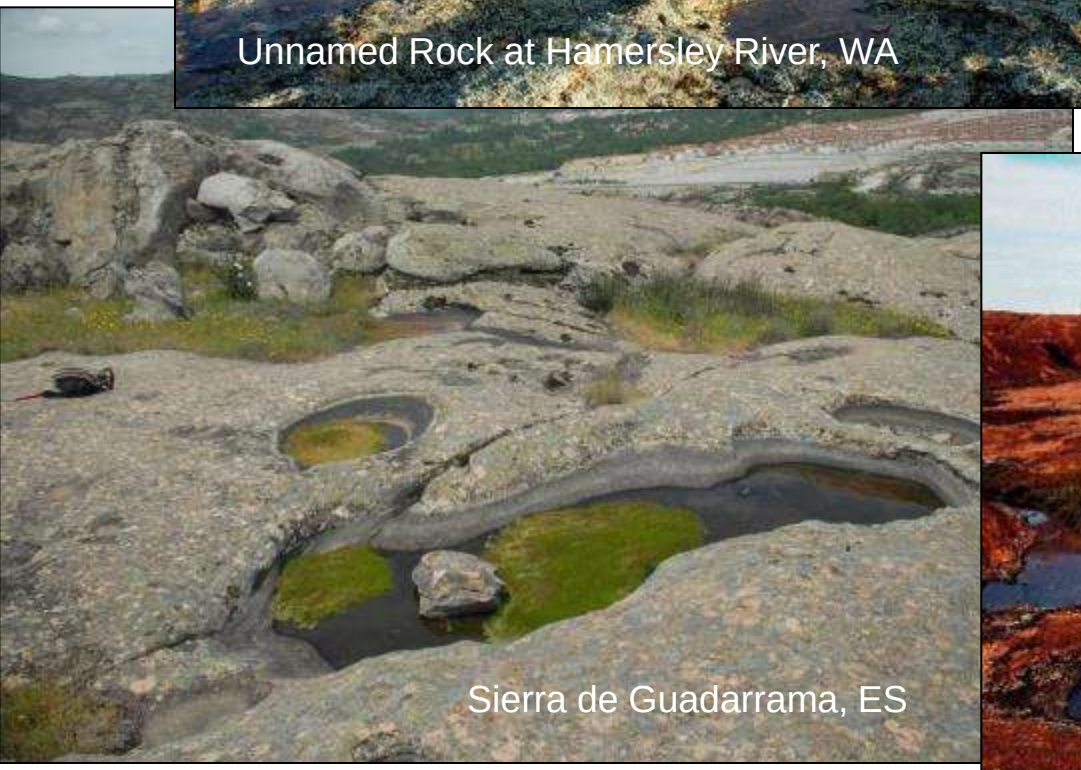
Riverine wetlands



Riverine wetlands with rock pools (*tinaja*)

Gnamma complex ('Consanguineous wetland suites')


Unnamed Rock at Hamersley River, WA

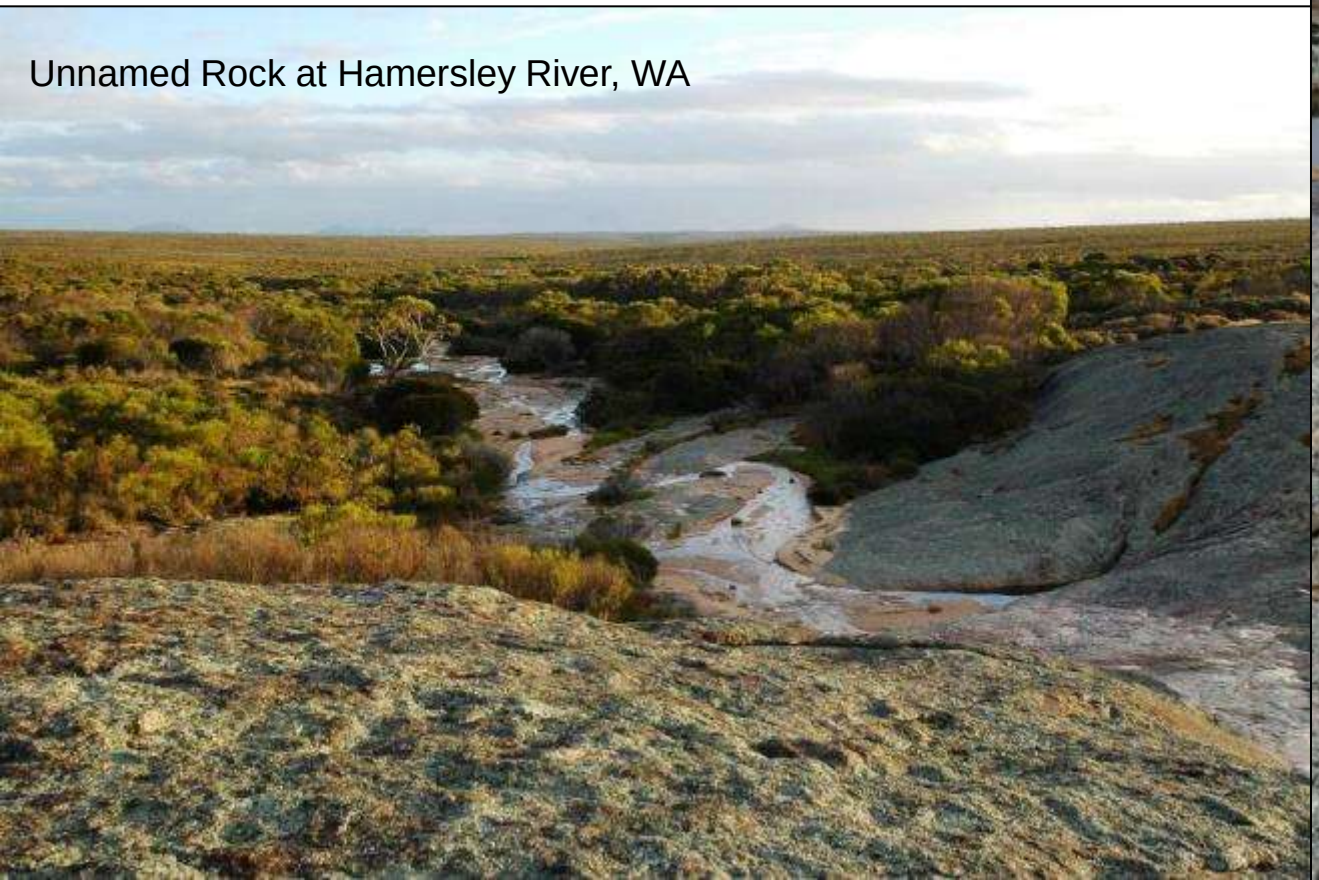

Sierra de Guadarrama, ES


Elachbutting Hill, WA

Hydrologic Functions:

(1) Surface & Shallow Subsurface Water Storage & Exchange

(2) Landscape Hydrologic Connections



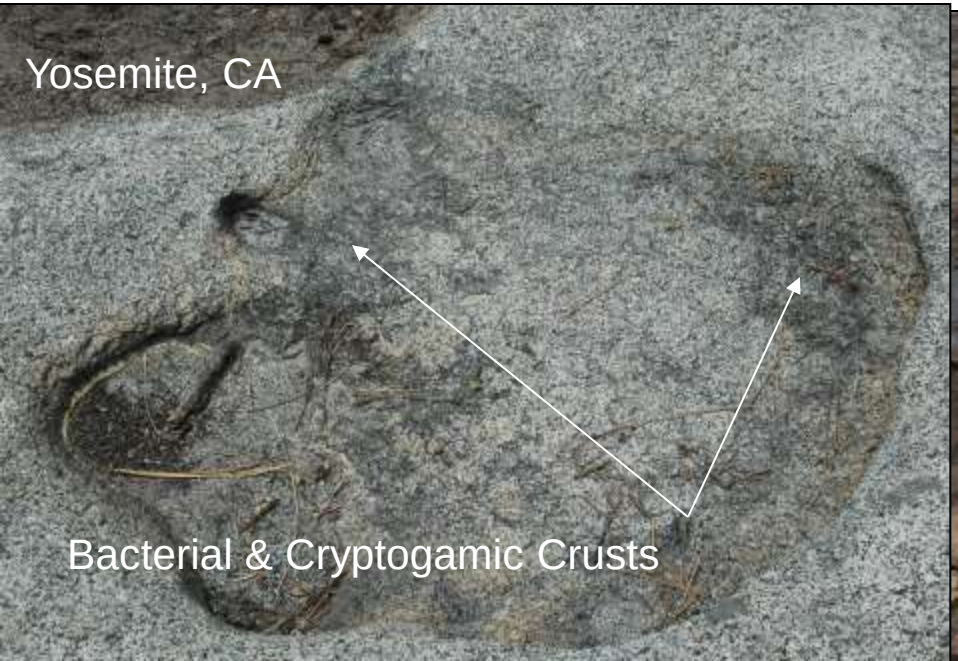
Biogeochemistry

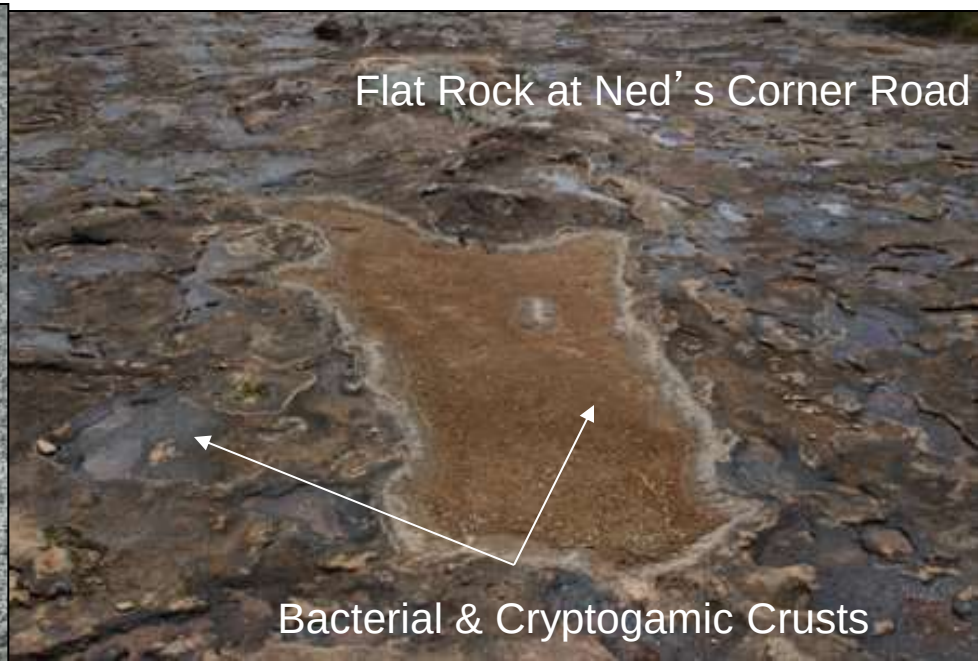
(1) Cycling of Elements and Compounds

(2) Detention of Imported Elements & Compounds

(3) Particulate Retention

(4) Export of Organic Carbon





Native Plant Community

(1) Native Plant Community Support

(2) Native Detrital Community Support

(3) Historical & Contemporary Refugia

Faunal Support/ Habitat

(Permanent, Partial, and Transitory Faunal Support (B Y Main 1997))

(1) Spatial Structure of Habitats

(2) Interspersion & Connectivity of Habitats

(3) Historical & Contemporary Refugia

Litoria sp.

Moaning Frog
(*Heleioporus eyrei*)

Quacking Frog
(*Crinia georgiana*)

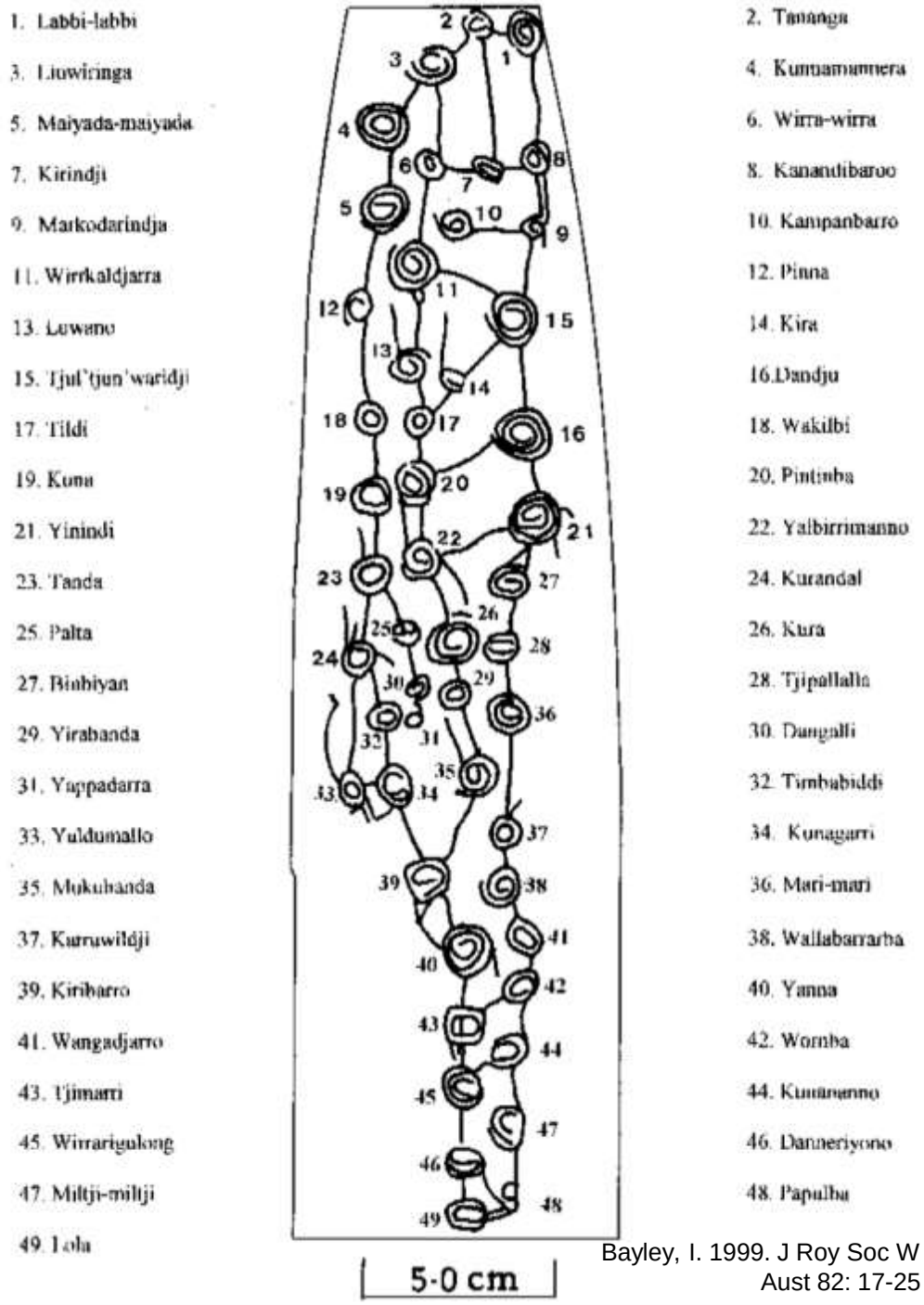
Glyptophysa sp.

Carlawillup, WA

Faunal Support

Humans and human use

Linda Syddick Napaltjarri *Walukurritje Rock Hole*



Bayley, I. 1999. J Roy Soc W Aust 82: 17-25

How could something so commonplace as a rock hole be so ***complex***?

Several ***modes of formation***
-above and below ground
- role of water, solar radiation, etc.

Several ***sizes & shapes*;** combinations thereof
-small, medium, large
- deep, shallow

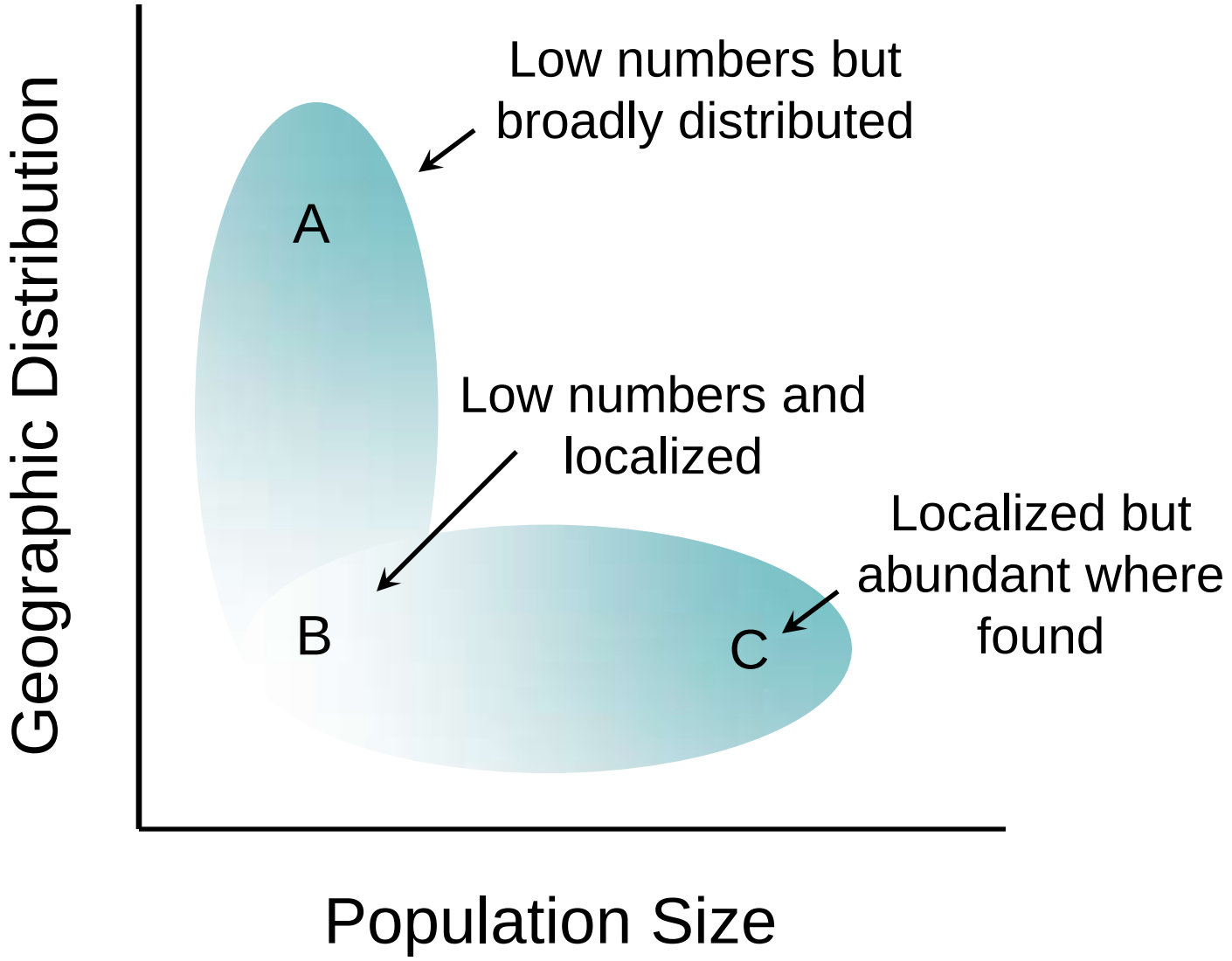
Several ***hydrologic regimes***
-seasonal, intermittent, permanent
-lotic vs. lentic
-isolated, connected, or seasonally both

Not explored here
-climate, age, pH, salinity, aspect, landscape setting, etc.

Four Axes of Rarity

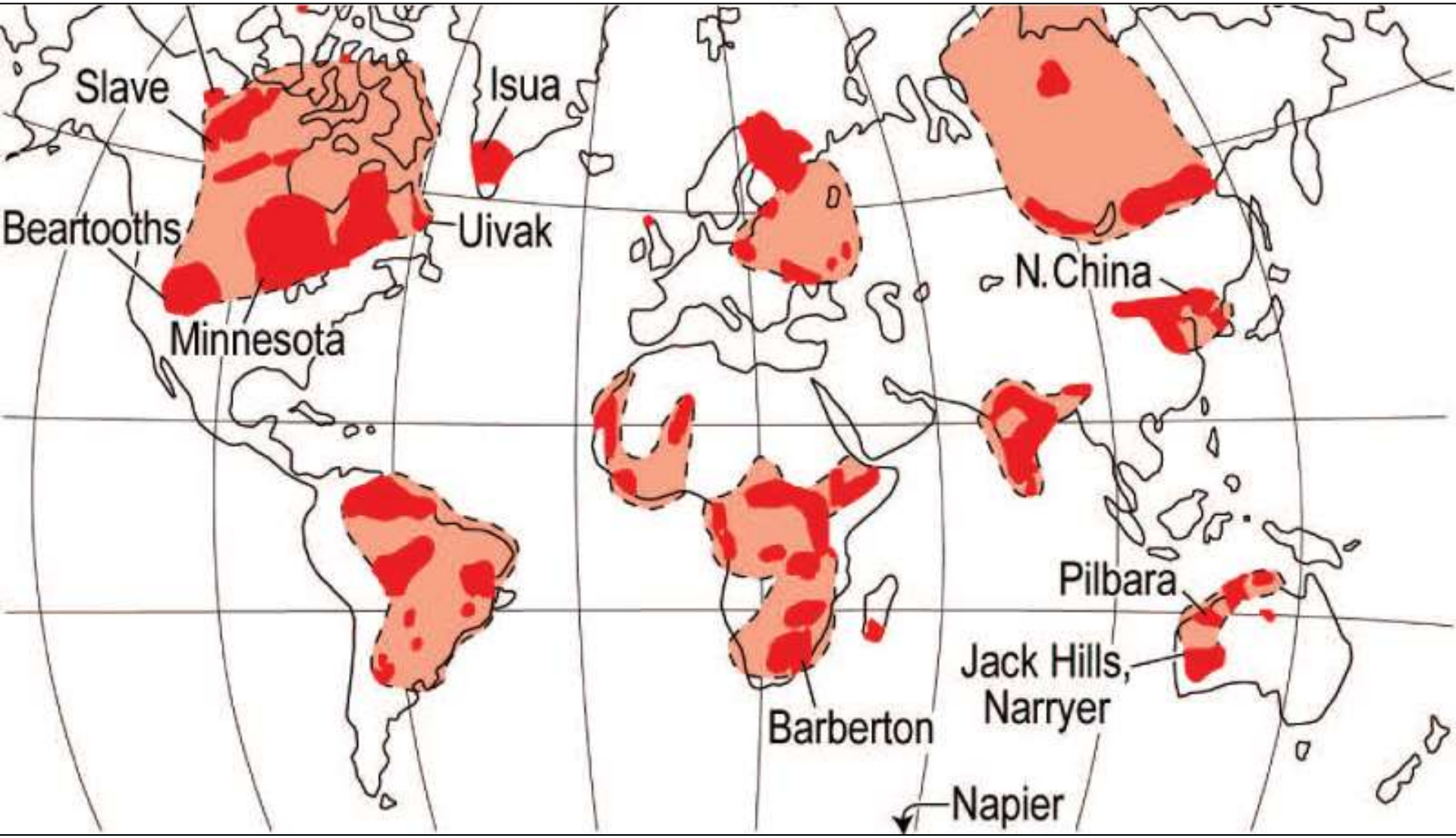
- Space
- Population Size
- Habitat Specificity
- Time

Two Axes of Rarity



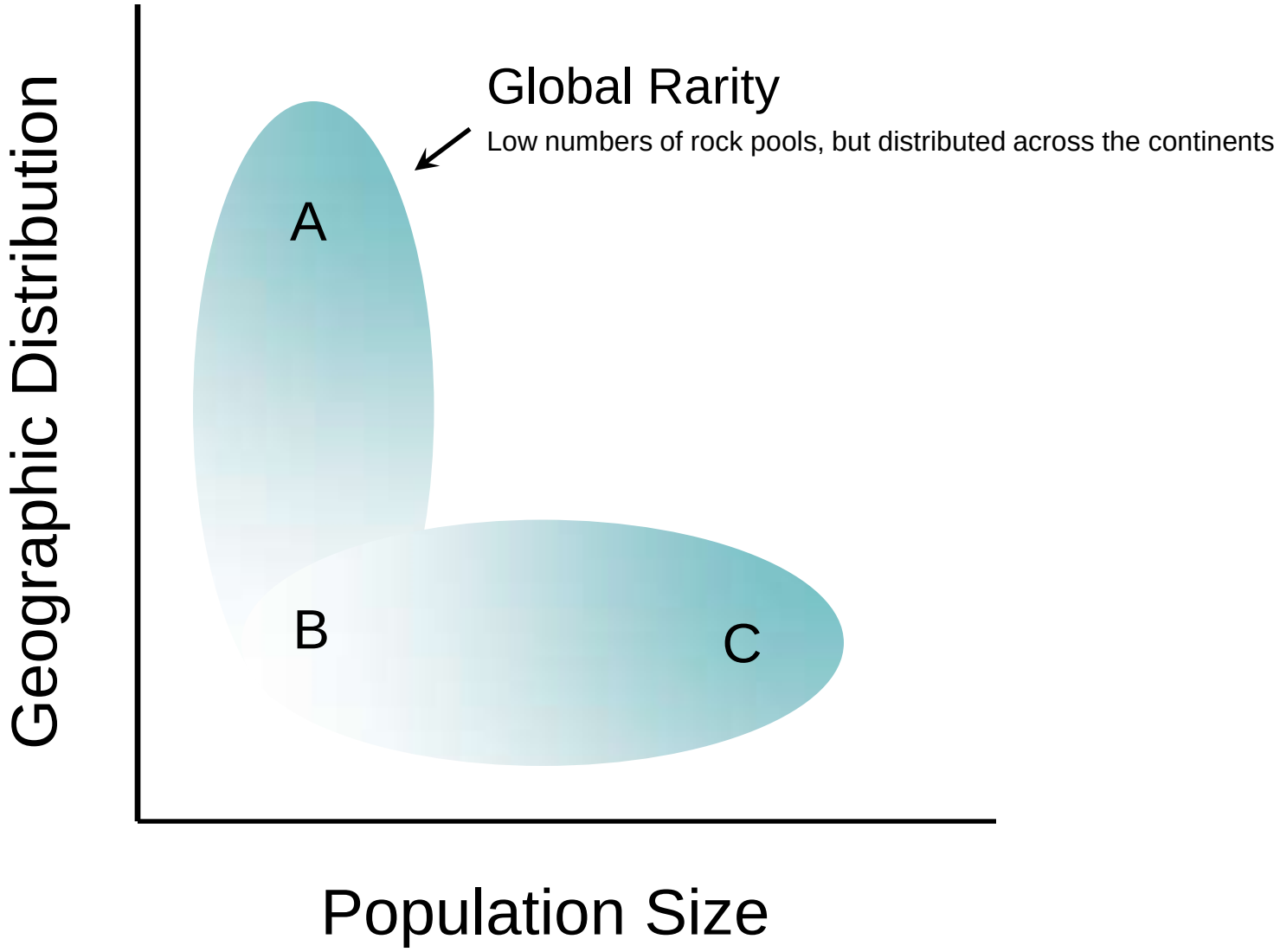
“Granite” Rocks Global Distribution

Archean (3,800 mya) rocks



http://www.earthsciences.hku.hk/shmuseum/earth_evo_03_archean_intro.php

Granite Rock Hole Rarity



Landscape Scale: Willapa Hills, WA Province, WA

Landcape Scale: Yosemite National Park

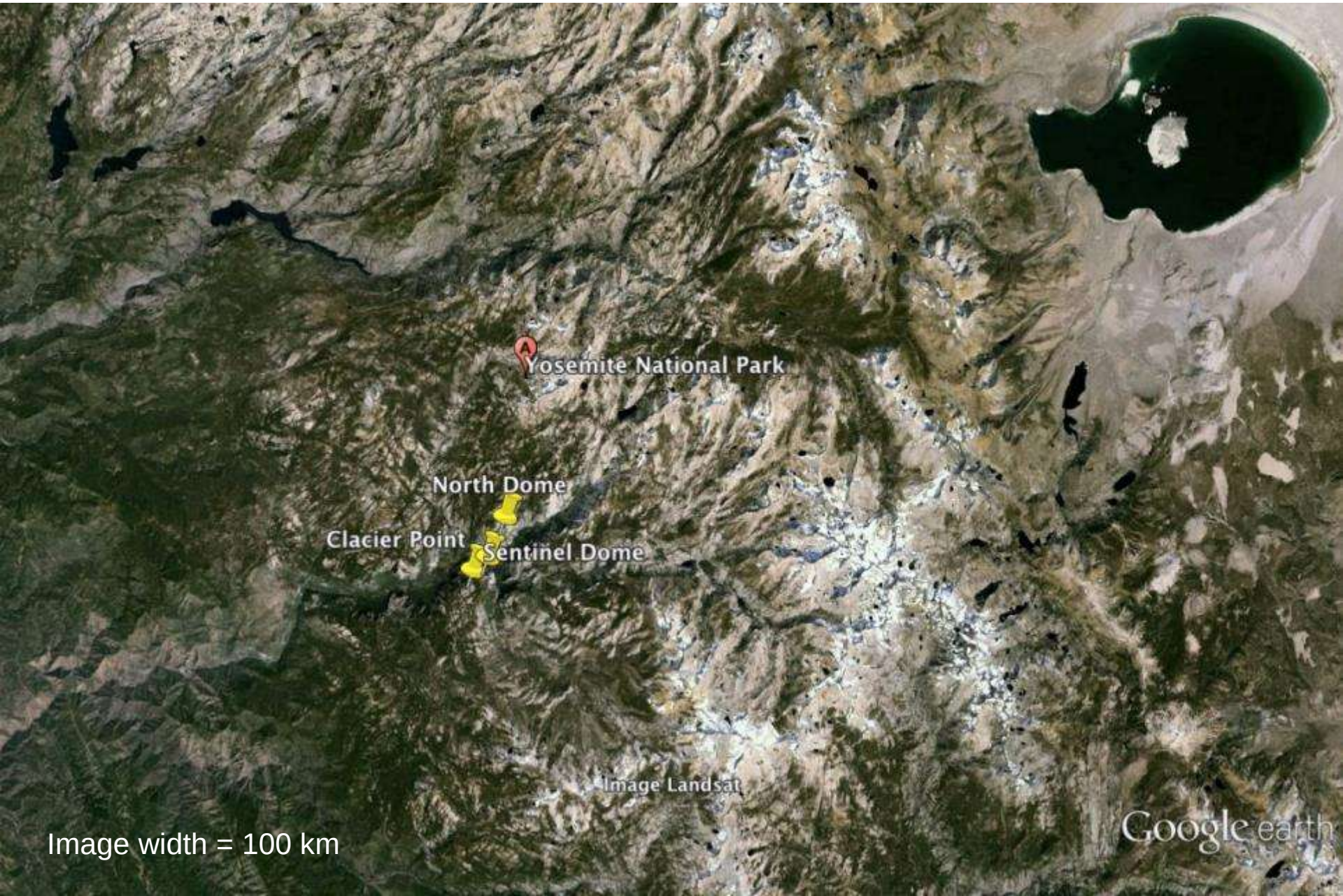
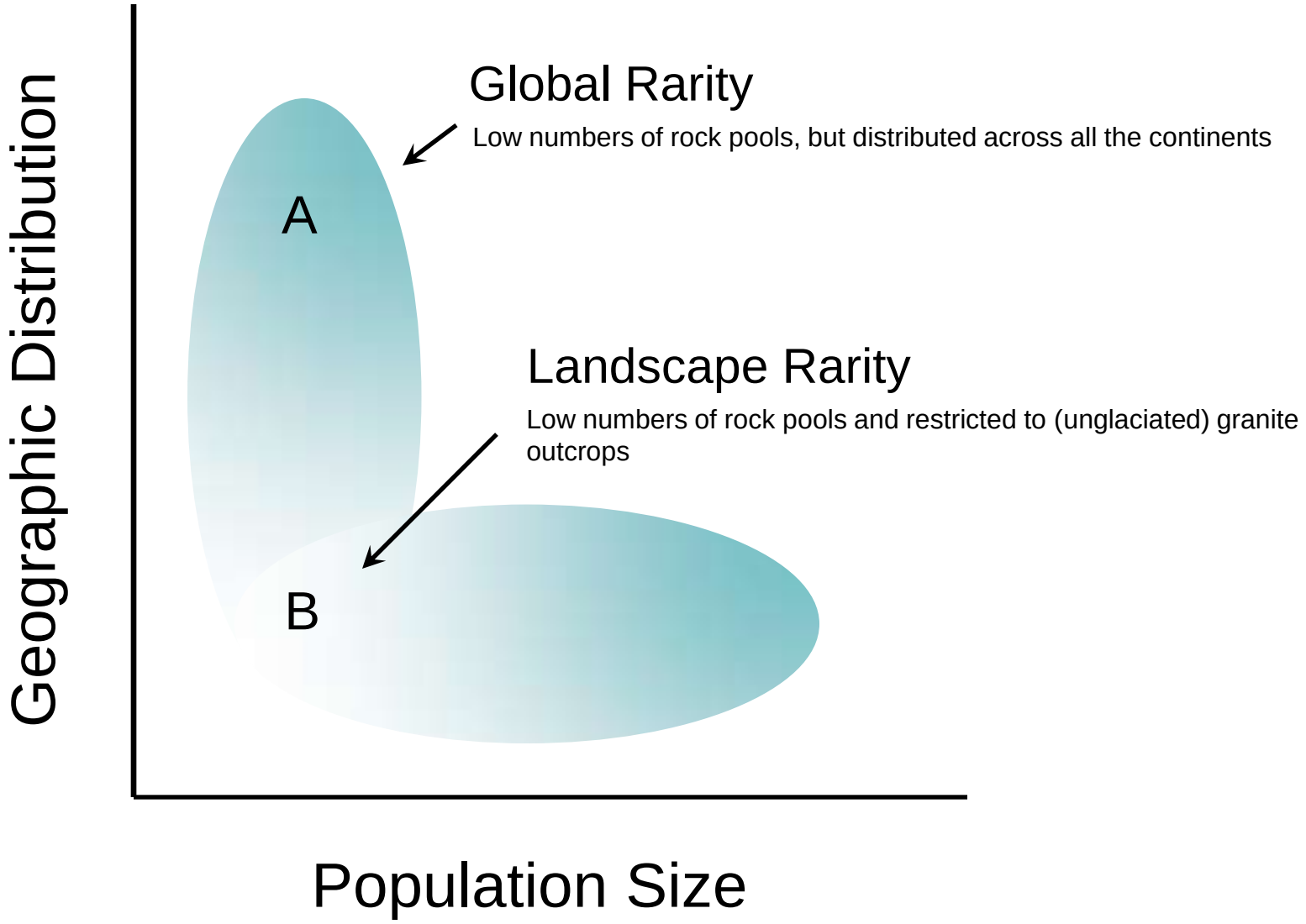


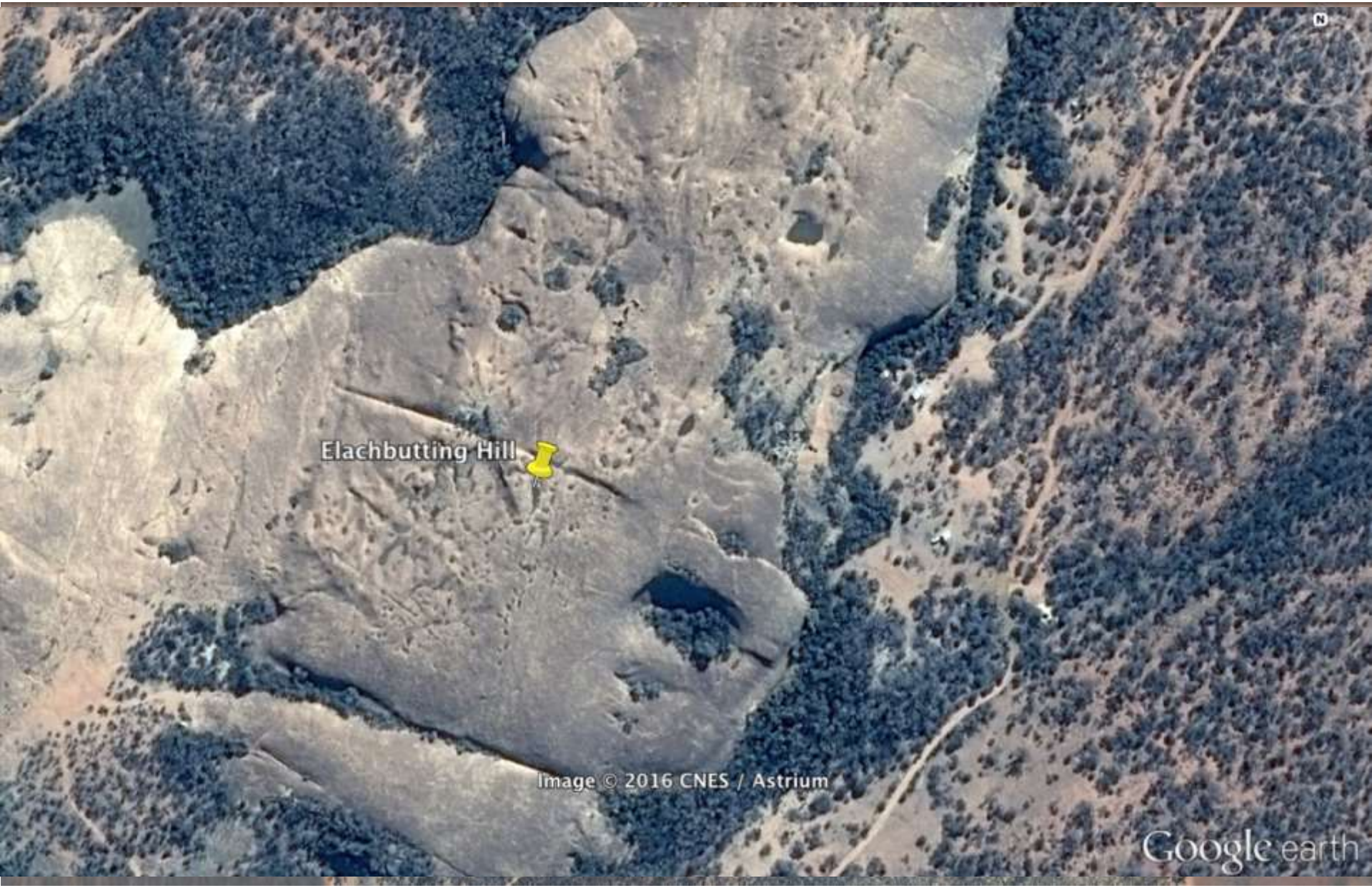
Image width = 100 km

Granite Rock Hole Rarity



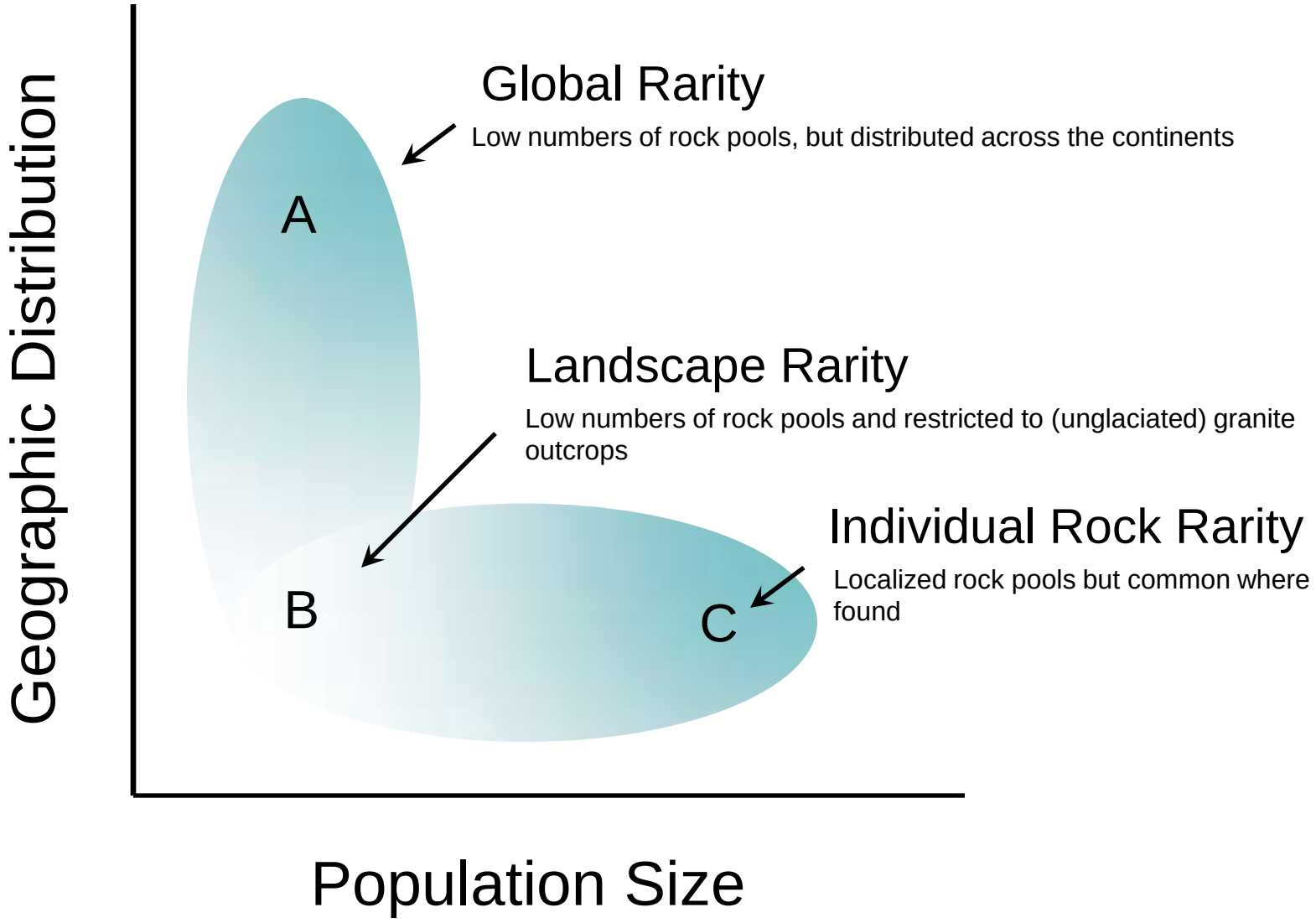
Individual Rock Scale: Afghan Rock

Individual Rock Scale: Elachbutting Hill



Individual Rock Scale: Yosemite National Park: Glacier Point

Granite Rock Hole Rarity

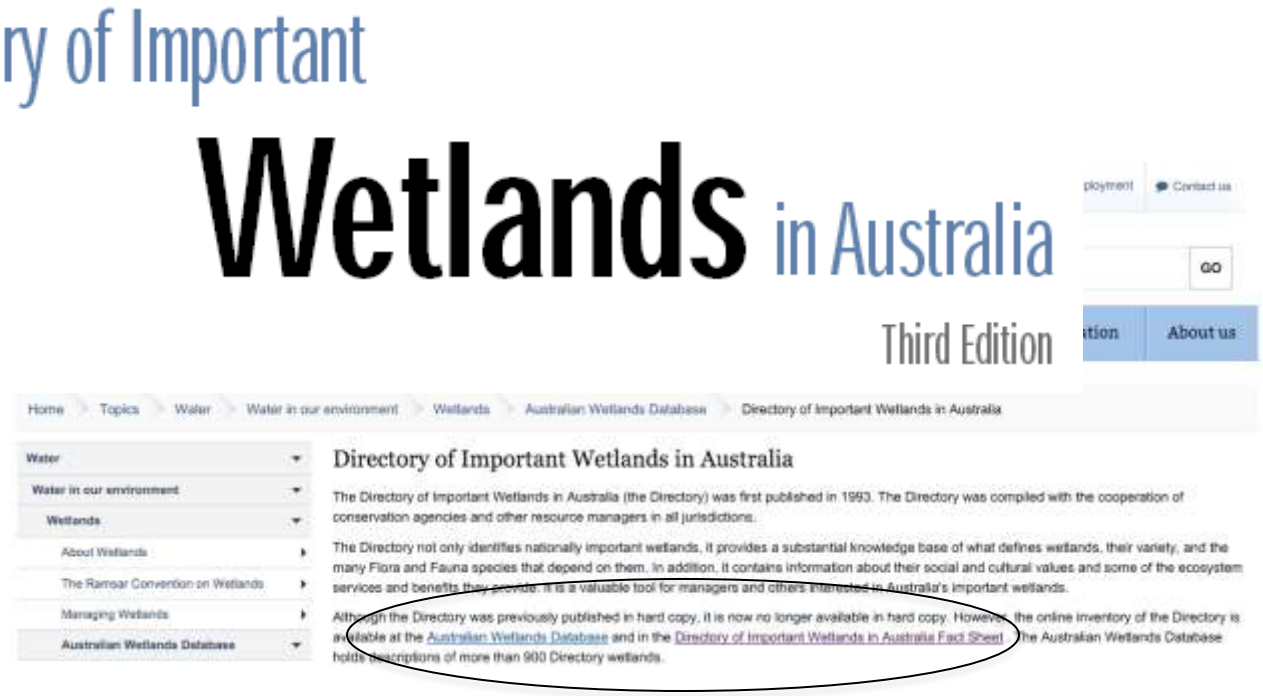


How could something so seemingly commonplace as a rock hole be so ***rare***?

Commonness and rarity for granite pools is a function of scale

- At an **individual rock** scale, restricted to particular surfaces where they commonly occur
- At at a **landscape** scale, both restricted faces and thus rare at this larger scale
- At a **global** scale, occur on all continents and thus rare at this largest scale

Protection for gnammas on continental & political scales



- 120/900 in Western Australia (0.13%)
- 4/120 are rock pool wetlands (4.4%)
- 1/120 are granite rock wetlands (0.8%)
- 1/4 located in SWAFR (Yorkrakine Rock Pools)
- 0.0001% of WA state landmass

Rock Pools of Breaden Hills

Northern Territory

Great Sandy Desert

Walter James Range

Gibson Desert Gnamma Holes

Lake Eyre

South Australia

Yorkrakine

Lake Torrens

Lake Gairdner

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

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Image Landsat

US Dept of State Geographer

Great Australian Bight

Spencer Gulf

Gulf St Vincent

Investigator Strait

Encounter Bay

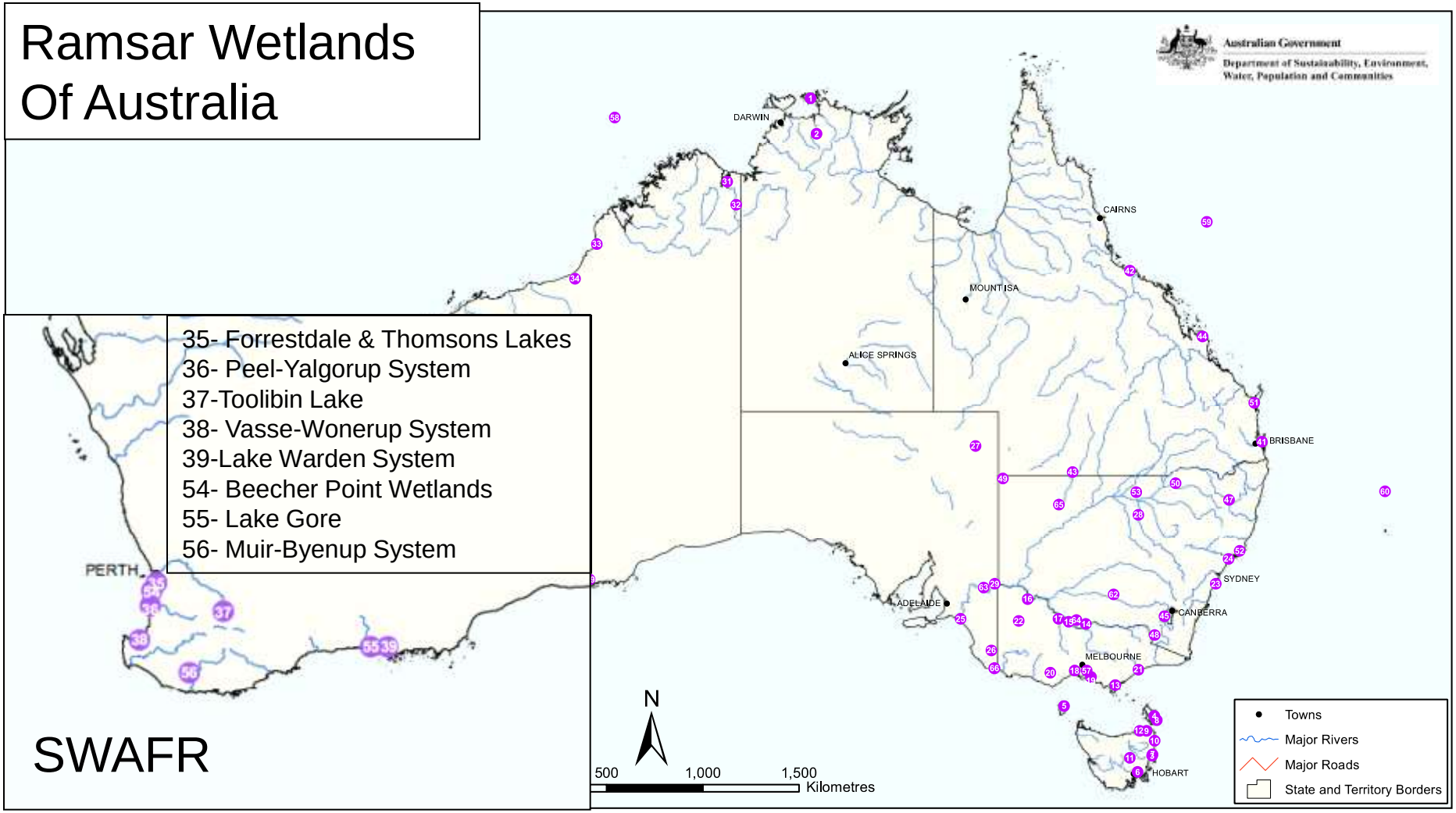
Google earth

Protection for gnammas on global scale

Ramsar Wetlands – Intergovernmental treaty that provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources

- 65 Ramsar Wetlands in Australia (>8.3 million ha)
- 12/65 in (continental) Western Australia (14%)
- 499,475 ha (6.0%)
- 0/65 are rock pools or rock pool mosaics (0.0%)
- 0.0% of WA state landmass

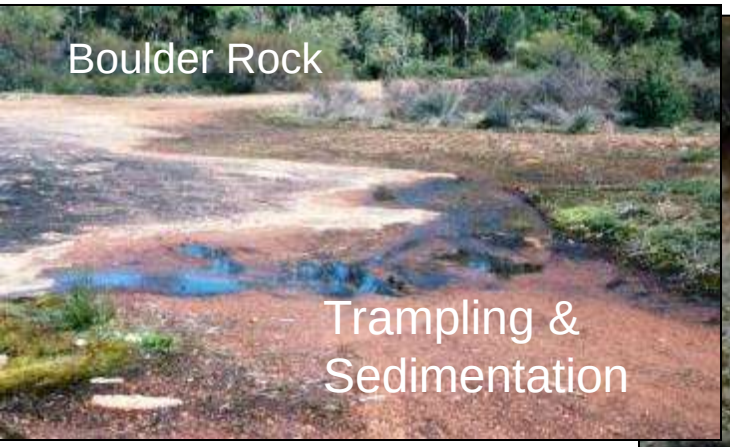
Ramsar Wetlands Of Australia

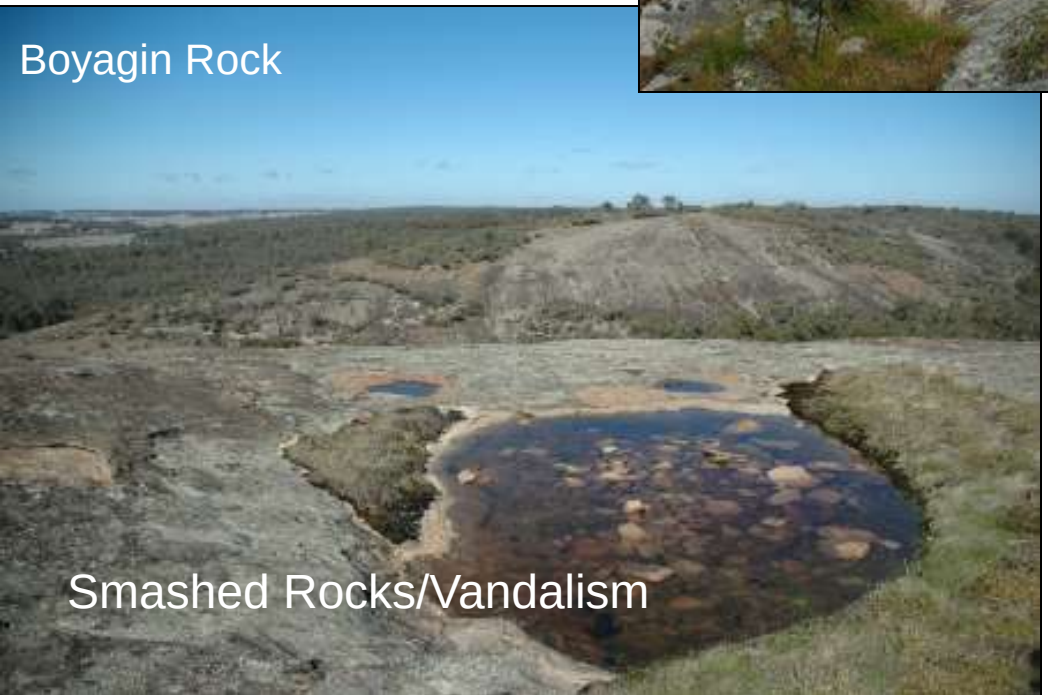


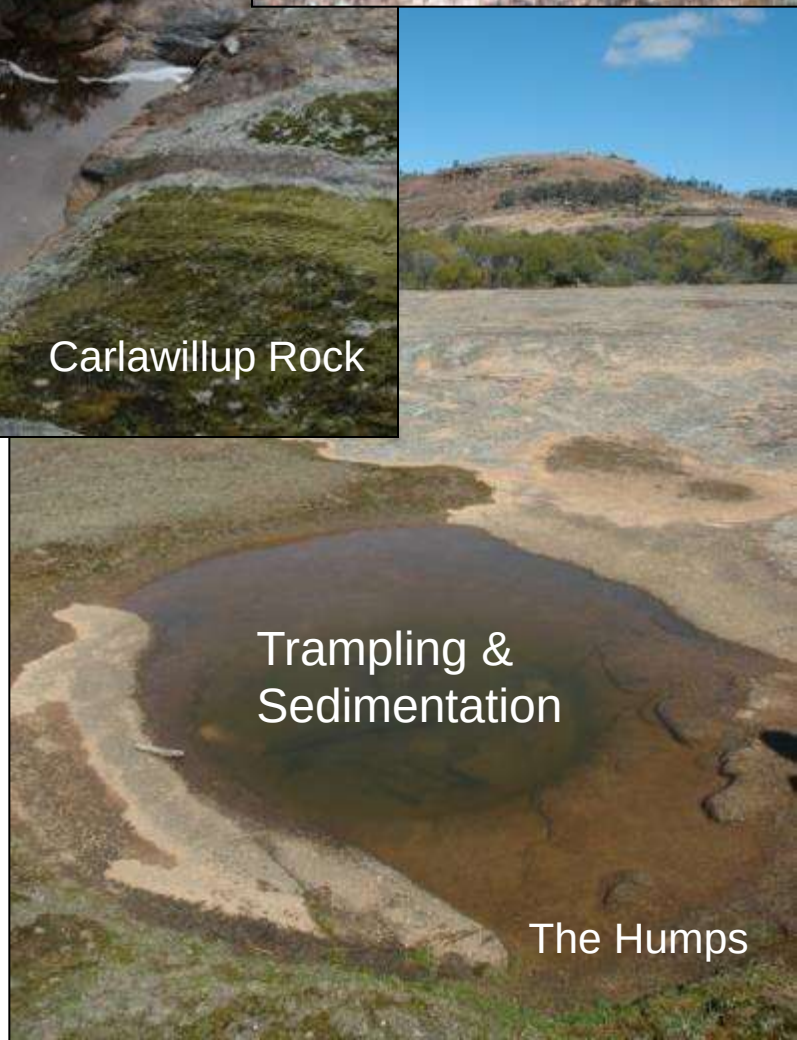
Ramsar Wetlands

1. Cobourg Peninsula
2. Kakadu National Park
3. Moulting Lagoon
4. Logan Lagoon
5. Lavinia
6. Pitt Water-Orielton Lagoon
7. Apsley Marshes
8. East Coast Cape Barren Islands Lagoons
9. Flood Plain Lower Ringarooma River
10. Jocks Lagoon
11. Interlaken (Lake Crescent)
12. Little Waterhouse Lake
13. Corner Inlet
14. Barmah Forest
15. Gunbower Forest
16. Hattah-Kulkyne Lakes
17. Kerang Wetlands
18. Port Phillip Bay (Western Shoreline) and Bellarine Peninsula
19. Western Port
20. Western District Lakes
21. Gippsland Lakes
22. Lake Albacutya
23. Towra Point Nature Reserve
24. Hunter Estuary Wetlands
25. The Coorong, and Lakes Alexandrina and Albert Wetland
26. Bool and Hacks Lagoons
27. Coongie Lakes
28. The Macquarie Marshes
29. Riverland
30. *This site was part of Kakadu National Park. In 2010 it was merged with site 2.*
31. Ord River Floodplain
32. Lakes Argyle and Kununurra
33. Roebuck Bay
34. Eighty-mile Beach
35. Forrestdale and Thomsons Lakes
36. Peel-Yalgorup System
37. Toolibin Lake
38. Vasse-Wonnerup System
39. Lake Warden System
40. Hosnies Spring(s) - Christmas Island
41. Moreton Bay
42. Bowling Green Bay
43. Currawinya Lakes
44. Shoalwater and Corio Bays Area
45. Ginini Flats Wetland Complex
46. Pulu Keeling National Park
47. Little Llangothlin Nature Reserve
48. Blue Lake
49. Lake Pinaroo (Fort Grey Basin)
50. Gwydir Wetlands
51. Great Sandy Strait
52. Myall Lakes
53. Narran Lake Nature Reserve
54. Becher Point Wetlands
55. Lake Gore
56. Muir-Byenup System
57. Edithvale-Seaford Wetlands
58. Ashmore Reef National Nature Reserve
59. Coral Sea Reserves
60. Elizabeth and Middleton Reefs Marine National Nature Reserve
61. "The Dales", Christmas Island
62. Fivebough and Tuckerbil Swamps
63. Banrock Station Wetland Complex
64. NSW Central Murray State Forests
65. Paroo River Wetlands
66. Piccaninnie Ponds Karst Wetlands

Degradation Processes







Fragmentation

Ned's Corner, WA

Replacement/ Destruction / Diversion

Concluding thoughts

- Many ways to be a rock hole; great variation within/among
- Rarest of the rare
- Perform critical ecosystem functions not replicated across the SWAFR and elsewhere
- Stewardship is essential