

# IODP Proposal Cover Sheet

926 - Pre

Great Australian Bight Reflux Brines

Received for: 2017-10-02

Title	Reflux brines: Linking Continental Shelf Hydrogeology to Subseafloor Microbiology		
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Keywords	Deep Biosphere, submarine groundwater discharge	Area	Great Australian Bight

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## Abstract

The role of mass transport in continental margin environments has historically been underappreciated. Recent oceanographic tracer studies indicate that discharge of saline groundwater from passive continental margins occurs at rates equal to (or exceeding) river discharge. This implies large-scale migration of saline groundwater through continental shelf sediments and is consistent with decades of research in carbonate diagenesis, where the importance of groundwater mass transport has long been recognized. We propose to assess coupled groundwater flow, geochemical reactions and microbial metabolic processes in the Great Australian Bight (GAB), a subtropical carbonate passive margin where prior drilling suggests that we will be able to access an actively discharging brine system.

The work of Jones et al. (2002) suggests that sea-level pumped reflux brines (brines formed by evaporation of seawater on the exposed shelf during sea-level minima) should be common in subtropical passive margin sequences. If so, they would provide the hitherto missing mechanism to explain the large-scale dolomitization and mineralization processes observed throughout Earth's history. These shelf-scale hydrological systems can be likened to enormous flow-through reactors which not only control diagenetic reactions (and by extension, seawater chemistry), but also support abundant deep microbial life on the upper shelf slope. Results from ODP-Leg 182 suggest that these brine-supported microbial ecosystems thrive under hyperalkaline and hyper-sulfidic conditions, which are profoundly distinct from most other known deep-biosphere environments.

Of all the DSDP/ODP/IODP cruises conducted over the years, less than ten expeditions cored locations where such brines were encountered. None of the cruises that intercepted high-salinity groundwater systems, had scientific objectives geared toward groundwater research to advance our knowledge of reflux brines and their associated deep-biosphere ecosystems.

Here we propose to revisit the outer shelf and upper shelf slope of the GAB, which was previously investigated by ODP Leg 182. We choose this location so that we can build on the already existing geochemical data from Leg 182, and because the GAB is considered a modern analogue of Mesozoic carbonate systems, not only in geometry but also in its microbial ecology. The tantalizing possibility is that we will gain an unprecedented glimpse into the microbial and organic geochemical processes that are responsible for the formation of a large portion of the world's hydrocarbon resources, as well as determine the role of saline groundwater flow in carbonate diagenesis in continental margin environments.

## Scientific Objectives

This proposal aims to A) Elucidate the age and formation mechanism of the hypersaline groundwaters on the shelf margin of the Great Australian Bight (challenge #14) ; B) Establish the extent and the flow rates of the GAB brine system, and evaluate its effect on seawater chemistry and mineralization potential (challenge #14); C) Explore how water and energy supply from terrestrial hydrogeological systems affect the dispersal, transportation and adaptation of microbes to the subseafloor deep biosphere (challenge #5, #13, #14); D) Explore how the GAB microbial ecosystem flourished under hypersaline and hyperalkaline condition (challenge #6) ; E) Explore how the GAB deep biosphere sustains methanogenesis in the presence of sulfate reduction, processes which are generally considered to be exclusive (challenge #6); F) Investigate how substrate changes across the Quaternary/Neogene boundary affect microbial ecology (challenge # 7). Note that our exploration of the effect of brine cycling on seawater chemistry also expands upon challenge #10, specifically suggesting that chemical exchange with continental shelf sediments should be considered as a control on the major ion chemistry of seawater.

### Non-standard measurements technology needed to achieve the proposed scientific objectives

Noble gas sampling, microbial cell counts and activity using a combination of cultivation, metatranscriptomics and stable and radiogenic isotope labelling. This will require the chemicals and a radioisotope container laboratory on the JR, similar to Leg 201 and Expedition 329, as well as shock freezing whole round core samples in liquid nitrogen.

## Proposed Sites (Total proposed sites: 8; pri: 7; alt: 1; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
GABW-01A (Primary)	-33.4400 127.6023333	589	600	0	600	GABW-01A is located at the foot of an Eocene delta sequence, which may, or may not act as aquifer to the brine. In the latter case we hope to sample to brine endmember chemistry as present within the aquifer, and to compare the chemical characteristics with the eastern brine exit site GABW-08A
GABW-02A (Primary)	-33.3700 127.6021583	345	700	0	700	Improve the spatial resolution of the western transect data, and extend the depth range of the existing data. Calibrate full vertical extent and hydraulic properties of Unit 7.
GABW-03A (Primary)	-33.3000 127.6024028	195	700	0	700	This site was chosen to expand the existing transect as much as possible towards the paleo shoreline
GABW-04A (Primary)	-33.2800 128.4808333	169	900	0	900	This is the northernmost site of the the Eastern Transect. We aim to expand the transect towards paleo shoreline during the last glacial; B) as well as to penetrate deeper into the brine, particularly below the microbially active zone
GABW-05A (Primary)	-33.3100 128.4808333	233	900	0	900	Increase data density in the eastern transect.
GABW-06A (Primary)	-33.3400 128.4808333	405	900	0	900	Increase data density in the eastern transect
GABW-07A (Alternate)	-33.3700 128.4808333	615	900	0	900	Alternate Site for GABW-08A which aims to capture the area where the brine body intersects with the seafloor (i.e., the exit zone). We expect that the mixing zone is shallow, and the low sedimentation rates will limit microbial activity
GABW-08A (Primary)	-33.4000 128.4808333	840	600	0	600	GABW-08A aims to capture the area where the brine body intersects with the seafloor (i.e., the exit zone). We expect that the mixing zone is shallow, and the low sedimentation rates will limit microbial activity.