GIANT DEEP-WATER SEEP MOUNDS ENCLOSED BY ANOXIC BASINAL CARBONATE STRATA: IMPLICATIONS FOR BASE METAL MINERALISATION IN THE MESOPROTEROZOIC BORDEN BASIN

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Polaris
1982-2002
22 Mt
14% Zn+Pb
Ordovician host

Nanisivik
1976-2002
17 Mt
10% Zn+Pb
Mesoproterozoic host

BORDEN BASIN
Zn- & Fe-RICH SHOWINGS

Pb-RICH, Zn-POOR SHOWINGS

FEW SHOWINGS
RENEWED TECTONISM (EXTENSIONAL/COMPRESSIONAL?)

ONGOING, SUBTLE TECTONIC ACTIVITY (FORMERLY CONSIDERED QUIESCENT)

RIFTING
TYPE SECTION (1956) OF SOCIETY CLIFFS FORMATION
St. George’s Society Cliffs, near Arctic Bay
275 m of dolostone between shales
PRECAMBRIAN CARBONATES: A TREASURE-CHEST OF INFORMATION
SOCIETY CLIFFS FACIES DISTRIBUTION ALONG GRABEN AXIS according to KAH, 1996

WEST (NANISIVIK) — EAST (TAY SOUND)

Zn/Pb

MID-RAMP

TRANSITION ZONE

INNER RAMP

Kah’s study area

EASTERNMOST BORDEN PENINSULA

- GYPSIFEROUS REDBEDS
- GYPSIFEROUS DOLOMUDSTONE
- INTRACLAST PACK-GRAINSTONE
- SUBTIDAL MICROBIAL DOLOSTONE
- PERITIDAL MICROBIAL DOLOSTONE
- OOID-INTRACLAST GRAINSTONE
- THINLY BEDDED DOLOMUDSTONE
DARK BROWN-WEATHERING LAMINATED DOLOSTONE
SOCIETY CLIFFS FM. LAMINITES

WITH ‘CRACKLE BRECCIA’

WITH ‘RUBBLE BRECCIA’
SOCIETY CLIFFS FM. LAMINITES

WITH ‘CRACKLE BRECCIA’

WITH ‘RUBBLE BRECCIA’

PERITIDAL

STROMATOLITIC
**LAMINITE PETROGRAPHY**

**Crackle Breccia** (voids filled with dolomite)

**Each Lamina Cored by an Organic-Rich Stylolite**

**LAMINITE STABLE ISOTOPE COMPOSITION**

$\delta^{13}C$ depleted by 2‰ relative to contemporaneous strata on platform

Deposited from water with high organic carbon content
RIMMED PLATFORM

NORTHWEST

MEAN LOW WATER
STORM WAVE-BASE
BASE OF PHOTIC ZONE

UPPER SOCIETY CLIFFS FM.

SOUTHEAST

DISTALLY STEEPENED RAMP

NORTHWEST

MEAN LOW WATER
STORM WAVE-BASE
BASE OF PHOTIC ZONE

LOWER SOCIETY CLIFFS FM.

SOUTHEAST
• NO LAYERING
• NO STROMATOLITIC FABRIC
• No layering
• No stromatolitic fabric
COLD SEEPS

The Methane Biosphere
A scientist aboard the German submersible Jago took this photo through a porthole nearly 750 feet below the surface of the Black Sea. Methane bubbles furiously from the stalagmite-like columns, which have been created by billions of evolutionarily ancient one-celled microbes that don't breathe oxygen.
COLD SEEPS

- FOCUSED VENTING OF LOW-TEMPERATURE FLUIDS ONTO SEA FLOOR
- DEEP WATER SETTINGS
- TECTONICALLY / GRAVITATIONALLY UNSTABLE AREAS
- FLUID COMMONLY CONTAINS METHANE
- METHANE CONSUMED BY BACTERIA, RESULTING IN CARBONATE PRECIPITATION
STORM WAVE-BASE

BASE OF PHOTIC ZONE

CHEMOCLINE

anoxic deep-basin water

methane oxidised by methanotrophic bacteria, producing carbonate

background deposition of hemipelagic shale

$\text{CH}_4$
Zn- & Fe-RICH SHOWINGS

Pb-RICH, Zn-POOR SHOWINGS

FEW SHOWINGS
GEOMETRY OF NANISIVIK MOUND AND ORE BODY

Victor Bay Formation shale

GAS

CAP

NANISIVIK ORE BODY

MOUND (uncompactable & impermeable)

Upper Society Cliffs carbonate laminites

Lower Society Cliffs shale
IMPLICATIONS OF PRIMARY FACIES DISTRIBUTION (MOUNDS AND BASINAL LAMINITES):

1 – PROBABLE DEEP-BASIN ANOXIA THROUGH 3 SHALE/CARBONATE FORMATIONS

2 – ONGOING SYNSEDIMENTARY TECTONISM & FLUID CIRCULATION

3 – PRESENCE OF BURIED MOUNDS

IDEAL FOR SEDEX

POSSIBLE EARLY MOVEMENT OF METALLIFEROUS FLUIDS?

MOUND GEOMETRY CONTROLS LATER FLUID FLOW (NANISIVIK MINERALISATION)