Remote predictive geological mapping as a tool for the reconstruction of the complex geodynamic evolution of Melanesia

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Rationale

- Geological maps play an important role not only for **mineral exploration targeting** but also for the further **understanding of the regional tectonic evolution**, especially when combined with remote sensing techniques to cover large areas (e.g., Goetz and Rowan, 1981; Brimhall et al., 2006)

- To date, no regional-scale (i.e. scale of 1:1 mio. or similar) geological maps **combining on- and offshore areas** have been published because of the scarcity of data used for conventional geological mapping

- Remote predictive mapping allows to create **first-order geological maps in highly remote or largely underexplored areas** (cf. Schetselaar et al., 2007)
Limited knowledge of the offshore

Offshore: Bathymetry only

Onshore: Geology & Mineral deposits

P.A. Brandl: Remote predictive mapping of PNG’s marginal seas
Stack of geological maps

Used for the creation of a simplified regional geological map (onshore)

Used for the informed geological interpretation of submarine features

P.A. Brandl: Remote predictive mapping of PNG’s marginal seas
Integrating global and ship-based bathymetry

Compilation of ship-based bathymetry

US, Japanese, Australian, French and German research cruises

Fused with GMRT

400,000 km² at 35-50 m resolution

Detailed geomorphology but limited coverage!
Vertical gravity gradient (VGG): guiding RPM

VGG: Important for the interpretation of tectonic elements and geological units (bedrock) under cover.

Focus site: The Tabar-Lihir-Tanga-Feni island chain (next slide)
One step forward: Geomorphological maps

Peninsula

Emirau-Feni Ridge

New Ireland

Deep

Lyra

Reef

Ontong Java Plateau

Tectonics

- Trench (inactive)
- Spreading Center
- Major Fault
- Major Fault (inferred)
- Minor Fault
- Minor Fault (inferred)
- Normal Fault
- Normal Fault (inferred)
- Ring Fault/Crater

Geology (onland)

- Raised Reef
- Intrusive Diorite
- Quaternary Volcanics
- Maton Conglomerate
- Ratman Formation
- Punam Limestone
- Nengmutka Volcanics (GP)
- Lelet Limestone
- Bergberg Formation (GP)
- Mera Volcanics (GP)
- Jaulu Volcanics

Geology (offshore)

- Mass Wasting Deposit
- Coral Reef
- Sedimentary Basin
- Relict New Ireland Basin
- Quaternary Volcanics
- New Britain Forearc
- Nuguria Ridge
- Emirau-Feni Ridge
- Shelf/Pedestal
- Extended Shelf
- Rifted Crust
- Lyra Basin
- Seamount
- Ontong Java Plateau

Collision

Brandl et al., 2020
Reconstruction of the geodynamic evolution

Lithostratigraphy is used for the creation of lithotectonic assemblages:

Regions that share a common geological and geodynamic history
Integration of petrology & geochemistry

Development of an ore deposit model:

Manus Basin

South Lihir Volcanic Field

Lihir

Emirau-Feni Ridge

Manus-Kilinailau Trench

New Ireland Basin

Sediments

Basement

Translithospheric faults & shear zones

Ladotam

Conical

New Ireland Basin

Breakdown of hydrous phases

Solwara-1

Backarc spreading

Oc. crust

Melt focusing

Lithospheric mantle

Metasomatized mantle

Slow subduction

Oceanic crust

Embracing concept of oceanic crust development

SW

Olivine

Pyroxene

Mica

Sulfide

Extensional

Compressional

Fault (inferred)

NE

Brandl et al., 2020

P.A. Brandl: Remote predictive mapping of PNG’s marginal seas
Summary

- Remote predictive geological mapping is a powerful tool for the **geological understanding of largely underexplored areas** (e.g., the deep sea)
- Based on existing knowledge and geophysical data
- **Iterative process** that will require future ground-truthing and revision
- Reconstruction of the geodynamic evolution using lithostratigraphy
- Integration of petrology & geochemistry helps to **develop ore deposits models** and may help to delineate future exploration targeting