The Panay Sill: Gateway to the Sulu Sea
(and contrast with the Lifamatola Passage)

Larry Pratt

(recollections of working with Arnold and his student Zach Tessler during the Philippine Archipelago Experiment PHILEX)

Rypina, Pratt, Levin, Pullen and Gordon 2010. Chaotic Advection in an Archipelago. JPO
(Arnold, do you remember this paper?)

Tessler, Gordon, Pratt and Sprintall, 2011. Transport and dynamics...Panay Sill. JPO
PHILEX Program
(Arnold was the boss)

Paney Sill/Sulu Sea Observations:

• 3 cruises spanning June 2007-Mar. 2009
• CTD and LADCP casts
• Bottom-moored ADCP at the Panay sill
Interface at $\sigma_\theta=26.42$

_interface at $\sigma_\theta=26.42$_
LADCP velocity
$\sigma_\theta$ from 2008 transect
Cross Sections from 2008 cruise (facing downstream)

potential density

LADCP velocity
Volume flow rate from rotating hydraulic theory

\[ Q = \frac{g'(1-\gamma)(1+\gamma)^3}{3rf(1+2/r)\gamma^2} h_o^2 \]

\[ \gamma = \left( \frac{\sqrt{6/r} - 1}{\sqrt{6/r} + 1} \right) \]

\[ r = \frac{f^2}{g'\alpha} \]

Borenas and Lundberg (1986, 1988)

Need to measure:

- \( h_o \) = layer thickness at saddle point
- \( \alpha \) = curvature of parabola fit to bottom cross section
- \( g' \) = reduced gravity (the Hobgoblin of weir formulas)

\( Q_{\text{observed}} = 0.32 \text{ Sv} \) time mean from mooring velocities

\( Q_{\text{theory}} = 0.32 \text{ Sv} \) average of \( Q \) values for 8 CTD casts at sill.
Panay Sill (570 m)

Sibutu Passage (234m)
Gordon, Tessler and Villanoy 2011: A mixture of water between 245 and 527m in the Sulawesi Sea would have the right salinity.

Liu and D’Sa, 2019
South China Sea  Panay Strait

Sulu Sea

Sibutu Passage  strong tides
Max overflow in spring tide

Sea Floor

Geothermal 115 mW/m²

11 year residence time

1.4 ml/l

0.9 ml/l

overflow depth depends on fortnightly tide and ENSO

1.2 ml/l

60 year residence time

1.8 ml/l

0.32 Sv

0.15 Sv

2.3 ml/l

Sill 234 m

Sill 570 m
Lifamatola Passage/Banda Sea

With Shuwen Tan, Dongliang Yuan and Corry Corvianawatie
Deep oxygen values nearly uniform at 2.77 ml/l. (Gordon et al. 2003)
12 W/m²

$\varepsilon \leq 1.1 \times 10^{-7}$ W/kg

$K \leq 4.7 \times 10^{-2}$ m²/s

$K = 1.6 \times 10^{-3}$ m²/s

1000 m

2.4 Sv

0.6-1.2 Sv

2000 m
Outlook

• Can the sloshing of the flow within the Sibutu Passage be observed (pirates!)?
• How does the deep water supplied to the Banda and Sulu Seas upwell (5000 to less than 1000 m)?
• What is the structure of the rotating hydraulic jump downstream of the Panay Sill.

Greetings to Arnold from the PO Dept at WHOI!