

# Potential Fields Pool Equipment (PFPE)

James Kinsey – [jkinsey@whoi.edu](mailto:jkinsey@whoi.edu)

Randy Herr – [Randyherr@aol.com](mailto:Randyherr@aol.com)

Dan Fornari – [dfornari@whoi.edu](mailto:dfornari@whoi.edu)



# Importance of Marine Gravimetry

- Improves scientific understanding of a variety of earth science problems
- Compared to satellites, marine gravimetry provides superior resolution, both in terms of minimum detectable spatial wavelength and the resolved gravity measurement
- Detailed studies of individual features continue to require shipboard gravity data

# Existing Infrastructure

- Prior to 2007, only 3 gravimeters were permanently installed on UNOLS vessels
  - BGM-3 gravimeters on the Ewing/Langseth and the Melville
  - A LaCoste and Romberg gravimeter on the Kilo Moana
- An agreement with NavO provided access to their gravimeters.
- NavO terminated their gravimeter program in 2007 forcing UNOLS to find an alternate source.

# 2007 Fugro Acquisition - Background

- In 2007, Fugro offered to sell used BGM-3 gravimeters and spare parts to the UNOLS community
- WHOI, SIO, and UAF successfully submitted a proposal to acquire this equipment (NSF-OCE-0705964)
- This equipment was refurbished and delivered to UNOLS by Randy Herr

Acquired equipment included:

- 7 working gravimeters
- 4 gyros
- 8 horizontal accelerometers
- Over 20 power supplies
- Over 20 boards



BGM-3 testing in Randy Herr's "Lab"

# 2007 Fugro Acquisition - Results

Gravimeter	Purchaser	In Service Date	Host Vessel (Operator)
S210 <sup>†</sup>	NSF	2011	<i>R/V Thompson</i> (UWash)
S213	LDEO	1984	<i>R/V Marcus Langseth</i> (LDEO)
S218	NSF	2007	<i>R/V Revelle</i> (SIO)
S219	NSF	2007	<i>R/V Knorr</i> (WHOI)
S220 <sup>‡</sup>	NSF	2007	WHOI (WHOI)
S221	NSF	2007	<i>USCGS Healy</i> (UAF)
S222*	NSF	2007	<i>USCGS Healy</i> (UAF)
S223 <sup>‡</sup>	NSF	2007	<i>CCGS Louis S. St. Laurent</i> (WHOI)
S224	SIO		<i>R/V Melville</i> (SIO)

† Scheduled to be installed in Spring 2011

‡ Pool gravimeter.

\* Scheduled to be transferred to the Arctic Regional Research Vessel (ARRV) in 2014.



Healy (left), Revelle (center), and Knorr (right) Installations. Image Credit: R. Herr

# Pool Gravimeters

- In addition to providing permanent gravimeters to 5 vessels, there are 2 pool gravimeters.
- Pool gravimeters are not permanently installed on a ship and available for use on any ship of opportunity
- Since 2007, these pool gravimeters have been used in the Red Sea, Guaymas Basin, Galapagos Spreading Center, and the Arctic.



Left, 2008 Oceanus install for the Red Sea cruise. Right, 2010 install on the CCGS Louis S. St Laurent for Law of the Sea work in the Arctic.



# PFPE – Motivation

- The acquisition of these gravimeters resolved the problem of *providing* gravimeters to the UNOLS fleet.
- It did not provide for the *long-term financial and technical support of this instrumentation*.
  - Technical support was occurring informally but there were no formal best practices.
- In 2009, Fornari and Kinsey discussed with LDEO, SIO, UAF, and WHOI the possibility of forming a gravimeter pool to share equipment and technical expertise.
- All of the operating institutions supported this initiative.
- In June 2009, the Potential Fields Pool Equipment facility was formed.
- An NSF award (NSF-OCE-0943618) for \$239k was awarded in Summer 2009 to provide equipment for PFPE

# PFPE – Goals

- PFPE provides the UNOLS community with:
  - A supply of spares for maintaining the at-sea BGM-3s
    - Repair or refurbish sensors as necessary
  - Technical Support including on-shore support for the at-sea gravimeters and helping establish best practices.
  - Two pool gravimeters for use of ships of opportunity or as complete emergency spares for the at-sea systems.
- PFPE does **NOT** post-process or archive marine gravity data
  - Such efforts are better suited toward other researchers or community initiatives.



# PFPE – Resources

- A SeaSPY towed marine magnetometer available for community use
- Pool gravimeters
- Land Gravimeters
- Gravimeter spares and equipment
  - \$55k in spares bought from Lockheed-Martin in 2009



# PFPE - Information

- Information on the pool gravimeters is located on the MISO website (Google 'PFPE WHOI')

WOODS HOLE OCEANOGRAPHIC INSTITUTION

## MISO Facility

Multidisciplinary Instrumentation in Support of Oceanography

Overview **MISO Instrumentation** Request an Instrument MISO Documentation

- MISO Instrumentation
  - TowCam
  - Marine BGM-3 Gravimeters**
  - Marine Magnetometer
  - Deep Sea Cameras and Strobes
  - Acoustic Transponders
  - High Temperature Loggers
  - Deep Sea Batteries & Switches

### Potential Fields Pool Equipment 'PFPE' - Ship BGM-3 Gravimeters

Share This Email Print RSS DCE

#### Background

In late 2006, an opportunity arose to acquire used BGM-3 gravimeters and spare parts from a commercial survey company, Fugro-Robertson, Inc. It was envisioned that acquisition of these gravimeters would result in permanently installed meters on several UNOLS Class 1 vessels, and that several meters that could be staged and installed on other ships on an as-needed basis (e.g., "pool gravimeters"). In order to take advantage of this opportunity, a group of scientists at University of Alaska at Fairbanks (UAF), Scripps Institution of Oceanography (SIO), and Woods Hole Oceanographic Institution (WHOI) wrote an unsolicited NSF proposal with WHOI as the lead institution to acquire the Fugro gravimeters and spares. That proposal (NSF-OCE-0705964) was funded in 2007 and over the course of the next 2 years, 4 gravimeters were permanently installed on the USCGS Healy, R/V Knorr, and R/V Revelle. This increased the number of permanently deployed BGM-3 gravimeters from two (the systems on the R/V Melville and R/V Marcus Langseth) to six. Two additional gravimeters were designated as pool gravimeters and, since 2008, have been deployed on cruises to the Pacific, Red Sea, and the Arctic.

The acquisition of seven BGM-3 gravimeters in 2007 through the NSF grant significantly increased the number resolved the problem of providing gravimeters to the UNOLS fleet, however it did not provide for the long-term financial and technical support of this instrumentation. To address this need, WHOI initiated a discussion with the marine gravity community and UNOLS ship operators to establish a gravimeter pool to share equipment and technical expertise with the ultimate goal of ensuring that all of the deployed BGM-3 gravimeters are well maintained and supported so that they can obtain high-quality marine gravity data. The pooling of equipment was intended to facilitate the purchase spares and needed repairs to gravimeters throughout UNOLS, thereby reducing the financial costs and logistical burden to the



[Enlarge Image](#)

One of the PFPE BGM-3 gravimeters during initial testing and refurbishment carried out by Mr. Randy Herr.

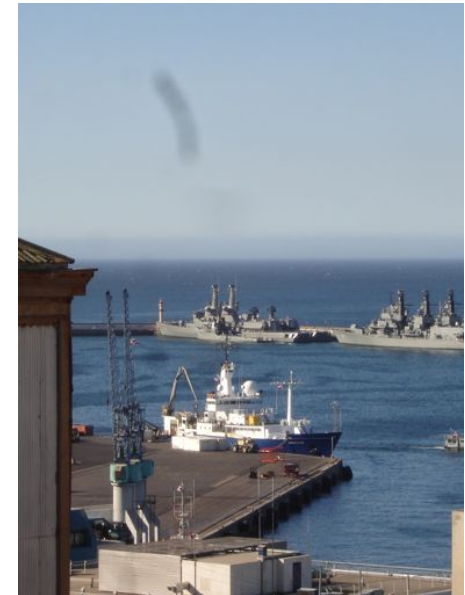


# PFPE – Technical Support

- 24/7 on-shore technical support from Kinsey and Herr and helping establish best practices.
- Visits for maintenance, cruise preparation, and emergency repair.
  - February 2010 service visit to the Melville in Valparaiso, Chile and subsequent equipment shipments.
  - April 2010 emergency shipment and installation on the Marcus Langseth in Portland, OR.



Left, emergency gravimeter shipment to the Langseth; Right, Melville in Valparaiso, Chile in February 2010.



# Recently Marine Gravity Cruises

<b>Vessel (Gravimeter)</b>	<b>Site</b>	<b>PI</b>
<i>R/V Oceanus</i> (S223)	Red Sea	Bower (WHOI)
<i>R/V Atlantis</i> (S223)	Guaymas Basin	Lizarralde & Soule (WHOI)
<i>R/V Atlantis</i> (S223)	Galapagos Spreading Center	Sinton (UHawaii) & Behn (WHOI)
<i>R/V Melville</i> (S224)	Northern Galapagos Region	Harpp (Colgate)
<i>R/V Revelle</i> (S218)	Chatham Rise	Collins (WHOI)
<i>L.S. St. Laurent</i> (S223)	Arctic	Childs & Hutchinson (USGS)
<i>USCGS Healy</i> (S221)	Arctic	Childs & Hutchinson (USGS)
<i>USCGS Healy</i> (S222)	Arctic	Childs & Hutchinson (USGS)

# PFPE – Present Status

- Working with the gyroscope manufacturer to fix refurbished gyros that failed soon after install
  - Likely cause was improper wiring at time of refurbishment
  - PFPE will be recalling some gyros early next year so they can be serviced by USD.
- Monitoring the LDEO gravimeter at WHOI and plan to return the unit to the Langseth in 2011.
- Scheduled install on the Tommy Thompson in April 2011.
  - PFPE will provide towed magnetometer and gravimeter technical support for the Tomaniga-Tivey cruise in Fall 2011.

# PFPE – Future Work

- Continue existing support services
- Work with the ship technicians to ensure gravimeters are calibrated and serviced as necessary
- In collaboration with the technicians and scientists:
  - Establish and document best practices
  - Work toward standardizing data formats and establishing at sea data quality control
- Coordinate these efforts with technicians, R2R, and researchers interested in developing tools for processing marine gravity

# Feedback from Yesterday's Focus Group

- Weekly Checks
  - Checks are time consuming – is there a way we can automate this?
    - Dale has some ideas. Dale and James are going to follow-up on this
  - Need a better way to transmit data to shore
    - Follow-up on better options
- Maintenance
  - Data buffer may have decadal scale issues with the memory
    - Assess situation starting with the Melville data buffers
    - Based on this assessment start rotating out data buffers for refurbishment
  - Batteries from the 2007 Fugro acquisition need replacement.
    - Add this to the to-do list for upcoming annual servicing
    - Replace the batteries on the Melville and Langseth units

# Feedback from Yesterday's Focus Group

- Data Logging and Quality Control
  - Coordinate with R2R to minimize overlap
  - Feedback from technicians on possible solutions
- Gravity Ties
  - Need to regularly perform gravity ties on all ships
    - Document the best practices for gravity ties
  - Frustration with locating gravity stations in foreign ports
    - Foreign gravity station databases are a source and should be employed
    - Better communication between institutions about recent gravity stations
      - A database of UNOLS established gravity stations (but not NGA)



# Feedback from Yesterday's Focus Group

- Best Practices
  - Checklists for daily, weekly, and annual maintenance
  - Standardized gravity ties
- An outline is drafted; need input from a working group on this
  - See next slide

## Contents

1	Introduction	5
1.1	System Orientation	5
2	Procedures	9
2.1	Surveying Procedures	9
2.2	Inspection Procedures	9
2.2.1	Daily Checks	10
2.2.2	Weekly Checks	11
2.2.3	Monthly Checks	11
2.3	Ship to Shore Gravity Ties	11
2.4	Land Gravity Ties	11
3	Gravity Logging Software	15
3.1	Basis	15
4	Data Quality Control	17
5	Troubleshooting	19
5.1	Test Procedures	19
5.1.1	Verifying Serial Communications on the Grav Log Laptop	19
A	Installation Configurations	21
A.1	Mobile	21
A.2	Linux S. St. Laurent	22
A.2.1	Serial Port Configuration	22
A.2.2	Initialization File	22
B	Data Formats	25
B.1	Raw Gravity Strings (RGS)	25
B.1.1	Modification History	26
B.1.2	Source Code	26
C	Modification History	29

# Action Items

- At this meeting will discuss with technical group managers:
  - Gyro swaps
  - Sharing of gravity station information
  - Establish a point of contact at each institution to assist with:
    - Best Practices Documentation
    - Coordinating between PFPE and the operating institution