

PATANIA II TRIAL: GSR UPDATE

A PRECAUTIONARY APPROACH TO DEVELOPING SEAFLOOR NODULE COLLECTOR TECHNOLOGY

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RESPONSIBLE SEAFLOOR NODULE COLLECTION

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Project Development

GSRNOD21 – Results

What's Next?





Date: April – May 2021 M/V Normand Energy (Solstad Offshore) GSRNOD21

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CAMPAIGN OBJECTIVES

<i>In situ</i> Technical Validation & Optimization	MiningImpact2 Experiments (JPIO)	Near Field Sediment Plume Assessment (MIT)	Oceanographic Moorings Data Download
 Nodule Collection System Propulsion System System Dynamics 	 Clearing an area of Nodules (GSR & BGR areas) Environmental Monitoring (before, during & after) 	 PATII Monitoring Equipment "Selfie" experiments (PATII Self-monitoring) Mooring "Drive-by" experiments 	Long term oceanographic recordings







TECHNICAL VALIDATION & OPTIMIZATION

COLLECTION EFFICIENCIES OPTIMIZED INTEGEGRATED PERFORMANCES



Main Results:

Hours on Seabed	107	[hrs]
Hours in Operation	226	[hrs]
Maximum Depth	4,551	[m]
Distance Travelled	54.2	[km]
Maximum Speed	0,63	[m/s]
Nodule Collection Rates	110 - 120	[T/hr]
Nodules Displaced	1,535	[T]



DEPTH OF SEDIMENT REMOVED



VISUAL OBSERVATION

[3cm - 5cm]

Qualitative Assessment

MULTIBEAM DATA

[Pending]

Quantitative Assessment

MIX-ITOMETER DATA

(Average concentration)

[3cm – 5cm] Quantitative Assessment





MININGIMPACT 2 EXPERIMENTS REALISTIC COLLECTOR TRIALS



GSR Objectives

- Minimal area to be cleared 22,000m² (per test area GSR & BGR)
- Simulate "commercial like" operations (η_{pick-})
- 8 monitoring moorings around test area (sediment plume & noise)







MININGIMPACT 2 EXPERIMENTS

REALISTIC COLLECTOR TRIALS





Nearfield Monitoring of Sediment Plumes

ЦВЛ

Prof. Thomas Peacock Environmental Dynamics Laboratory Massachusetts Institute of Technology



Instrumentation



Instrument	Quantities Measured	Deployment Platform	Number of
			Instruments
Acoustic Doppler Current	Vertical profiles of ocean currents,	Patania II, Moorings	13
Profilers (ADCPs)	Sediment loading of water column		
Acoustic Current Meters	Point measurements of ocean currents	Moorings	5
Camera Imagery	Qualitative observations of suspended sediment and biology	Patania II	5
Conductivity, Temperature	Conductivity and temperature of	Patania II, Moorings	3
and Density (CTD)	seawater		
Hydrophone	Acoustic noise levels	Mooring	1
Multibeam	Sediment removal and deposition,	Patania II, AUV	2
	Sediment loading of water column		
Optical Turbidity Sensors	Sediment loading of the water column	Patania II, Moorings	23
Sediment camera In-situ particle size distribution, Ocean		Patania II	1
	microbiology		
Sample Bottles	Lab based analysis of geochemistry,	Patania II	20
	biology and sediment		





Selfies

- 8 Selfies were conducted
- Patania II drove 100m with active collection heads
- Patania II executed three 90° turns and drove back through the sediment plume
- Instruments on Patania II monitored the plume



Drive-Bys



- 4 Drive-Bys were conducted
- Patania II drove 100m with active collection heads, in close proximity (50-100m) to a heavily instrumented mooring
- Instruments on Mooring monitored the plume



GSR MI2 Trials



- Monitor sediment disturbance in the mining site using instrumentation on Patania II.
- Monitor sediment disturbance coming from the mining site using instrumentation on 7 moorings around the mining site.
- Analyzing data from 3 moorings recovered



LISST-RTSSV Sensor





- New deep-ocean sediment sensors being developed by MIT, Scripps and Sequoia Scientific, funded by ARPA-E
- Mounted on top of Patania II to monitor sediment in suspension
- Operated during selfies and BGR collector trials

Thanks



Prof. Thomas Peacock (Principal Investigator)



Dr. Raphael Ouillon (Sediment transport & ocean modeling)



Prof. Pierre Lermusiaux MSEAS, MIT.



Dr. Carlos Munoz Royo (Field studies, economic model)



Souha El Mousadik (Sediment characterization)





Lap

OCEANOGRAPHIC MOORINGS DATA DOWNLOAD

BACKGROUND OCEANOGRAPIC DATA



Recovery:

MOR003	~4,000m	02/06/2017	~3 years
MOR007	~45m	16/02/2018	~2.5 years
MOR008	~30m	28/02/2018	~2.5 years
MOR009	~15m	11/03/2018	~2.5 years

Redeployment:

MOR010	~33m	11/05/2021	~ years	3 x ADCPs
MOR011	~3,900m	12/05/2021	~ years	5 x ADCPs; 1 x CTD; 2 x Current meters; 2 Sediment Tra
MOR012	~24m	12/05/2021	~years	2 x ADCPs; 1 x CTD

4 x ADCPs; 4 x DVS; 1 x CTD; 2 Sediment Traps

1 x ADCPs; 3 x Current meters

2 x ADCPs; 1 x Current meter

2 x ADCPs; 1 x CTD



What's Next?



Strategy & Schedule



SYSTEM INTEGRATION TEST

Subsea Commercial Scale





PATANIA III | FULL SCALE SNC

Prototype Vehicle



Strategy & Schedule

Continuous Learnings (<u>113</u> listed items)

Minimizing Sediment Plume Dispersion

- Optimize Nodule Collection System
 - Reduce pick-up water flow
 - Recirculation of water
- Optimize the diffusor design
- Optimize the mining plan (~COMPASS)
- Optimize the hydrodynamic shape
- Other Learnings related to the Sediment Plume
- Review mudguards around track boxes
- Optimize placement of environmental sensors (continual improvement as a monitoring platform)

Re-visit Test Site For Long Term Learnings

BEHIND THE SCENES

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