EGI Energy & Geoscience Institute
AT THE UNIVERSITY OF UTAH

Since 1972

IN DEVELOPMENT

Basin Analysis & Petroleum Systems of Western SE Asia – Myanmar to Java –

Principal Investigators:

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Investment per Sponsor
$76.5K (USD)

Duration
12 months

Project I 01233

VALUE

- Summary for the regional tectonics and basin evolution in western SE Asia, running North – South, from Myanmar to Java Island region;
- Comparison of the geology and petroleum systems of back-arc, fore-arc and fore-deep basins on a regional basis;
- Recommended play exploration opportunities in both frontier basins and exploration mature basins;
- Compendium with predictive models addressing the similarities and dissimilarities of petroleum systems in back-arc, fore-arc and fore-deep basins in different tectonic settings prioritized for exploration strategy or as analogs for exploration in other similar basins in the world.

KEY DELIVERABLES

1. ArcGIS based database including regional tectonic and depositional maps, stratigraphic charts and stratigraphic cross sections for each basin and/or sub-basins, maps of Petroleum system elements and chart, modeled burial and thermal history and hydrocarbon migration and accumulation results, play maps, potential plays, examples and models for basins in trench-slope fore-deep, fore-arc and back-arc settings.
2. Interim data uploads (2 to 3) during the course of the research.
3. Meeting presentations and project report (both digital and hardcopy);
4. Reliable bibliographic database

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Objectives

- Summarize the regional tectonics and basin evolution in western SE Asia, running North – South, from Myanmar to Java Island region;
- Investigate and compare the geology and petroleum systems of back-arc, fore-arc and fore-deep basins on a regional basis;
- Recommend play exploration opportunities in both frontier basins and exploration mature basins;
- Summarize the predictive models addressing similarities and dissimilarities of petroleum systems in back-arc, fore-arc and fore-deep basins in different tectonic settings for companies to prioritize exploration strategy or use as analog for exploration in other similar basins in the world.

Scope of Work

1. Collect, compile, archive, synthesize and interpret data from basins in western Southeast Asia corridor from Myanmar to Java.
2. Conduct basin-wide geological study, tectono-sequence stratigraphic and, depositional analysis;
3. Analyze basin geohistory and petroleum systems based on regional mapping of geology and petroleum elements, basin modeling, and analysis of discovered fields and a re-examination of failed exploration areas by integrating geology, geophysics, outcrop, wells and geochemistry data
4. Identify potential new plays by new data interpretation, play fairway mapping and integrated basin analysis and petroleum system study in key data-rich onshore and offshore basins in Western SE Asia; Exploration opportunities in data-poor frontier basins will be predicted through knowledge learned from other already producing analog basins with similar geology.
5. Compare basin evolution and characteristic hydrocarbon accumulation habitats between back-arc, fore-arc and fore-deep basins in similar and different tectonic settings.
6. Summarize common petroleum systems for each type of basin and variations of petroleum system models from Indian Ocean subduction-influenced Myanmar to Australia Plate subduction-influenced Java.
7. Deliver on ArcGIS platform with a written report and documentation.

Project Rationale & Motivation

Similar to other rift basins in China and East Africa, basins in SE Asia have been explored since the 19th century and contain globally significant petroleum resources especially the Cenozoic aged basins (Figure 1). The basins on the Sunda Shield and Myanmar micro-plate are located in a complex tectonic setting due to interactions between the India, Eurasia, Philippine, and Australia Plates. Most basins have characteristic back-arc and fore-arc settings, and were influenced by strike-slip movements related to the escape tectonics of the IndoChina Block in response to the collision between the Indian and Eurasia plates (Tapponier et al., 1986, Hall, 1996; Longley, 1997) (Figure 2). Basin architecture and source rock development and petroleum systems have been strongly controlled by Tertiary-aged tectonics linked with extrusion tectonics, back-arc and fore-arc extension, and intra-cratonic rifting associated with convergence of the IndoAustralian and Eurasian Plates. For the western SE Asia, the tectonics are mainly influenced by the subduction of Indian-Australian oceanic plate. Many fore-deep (slope trench), fore-arc and back-arc basins are related to the subduction and formed from active margin to back-arc extensional settings (Figure 2, Figure 3).

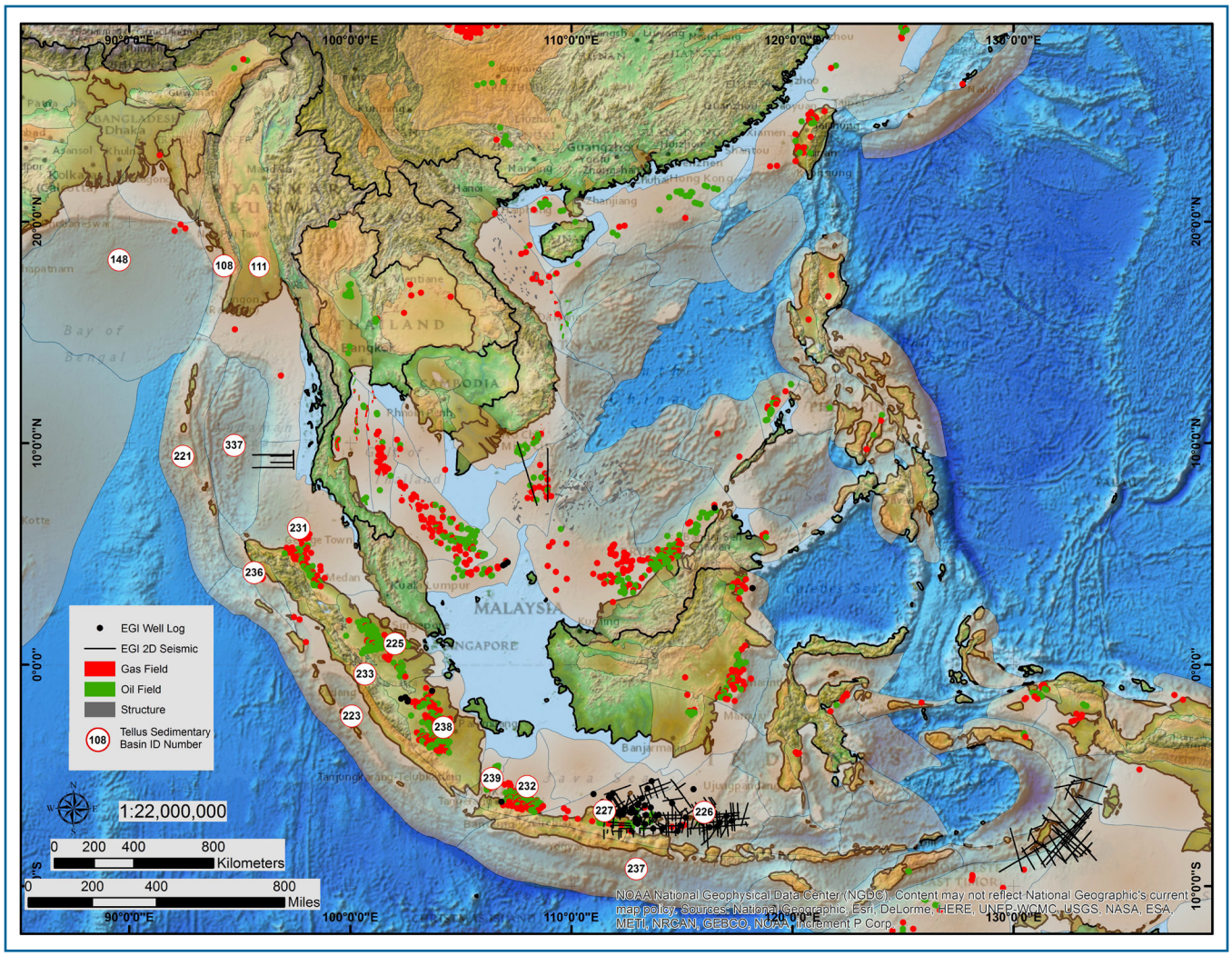

Figure 1 Key producing and frontier basins in SE Asia. See Table 1 for key basins covered in this study in western SE Asia.

Table 1 Key frontier and producing basins covered in this study. (See Figure 1 for basin code.)

Proposed Basins	Basin Number Code (Refer to Figure 1)	Basin Type	Countries Associated with Basins
Central Myanmar Basin	111	Back-arc	Myanmar
Arakan	108	Fore-arc	Myanmar
Rakhine Basin in Bay of Begal	148	Trench-slope	Myanmar
Andaman Sea Basin	337	Back-arc	Myanmar, Thailand, Indonesia
Nicobar- Andaman	221	Fore-arc	India
Northern Sumatra-MERGUI	231	Back-arc	Indonesia
Sibolgo	236	Fore-arc	Indonesia
Central Sumatra Basin	225	Back-arc	Indonesia
Ombilin	233	Back-arc	Indonesia
Bengkulu Basin	223	Fore-arc	Indonesia
South Sumatra Basin	238	Back-arc	Indonesia
Sunda Asri Basin	239	Back-arc	Indonesia
NW Java Basin	232	Back-arc	Indonesia
Java Sea Basin	227	Back-arc	Indonesia
South Java Basin	237	Fore-arc	Indonesia
East Java Basin	226	Back-arc	Indonesia

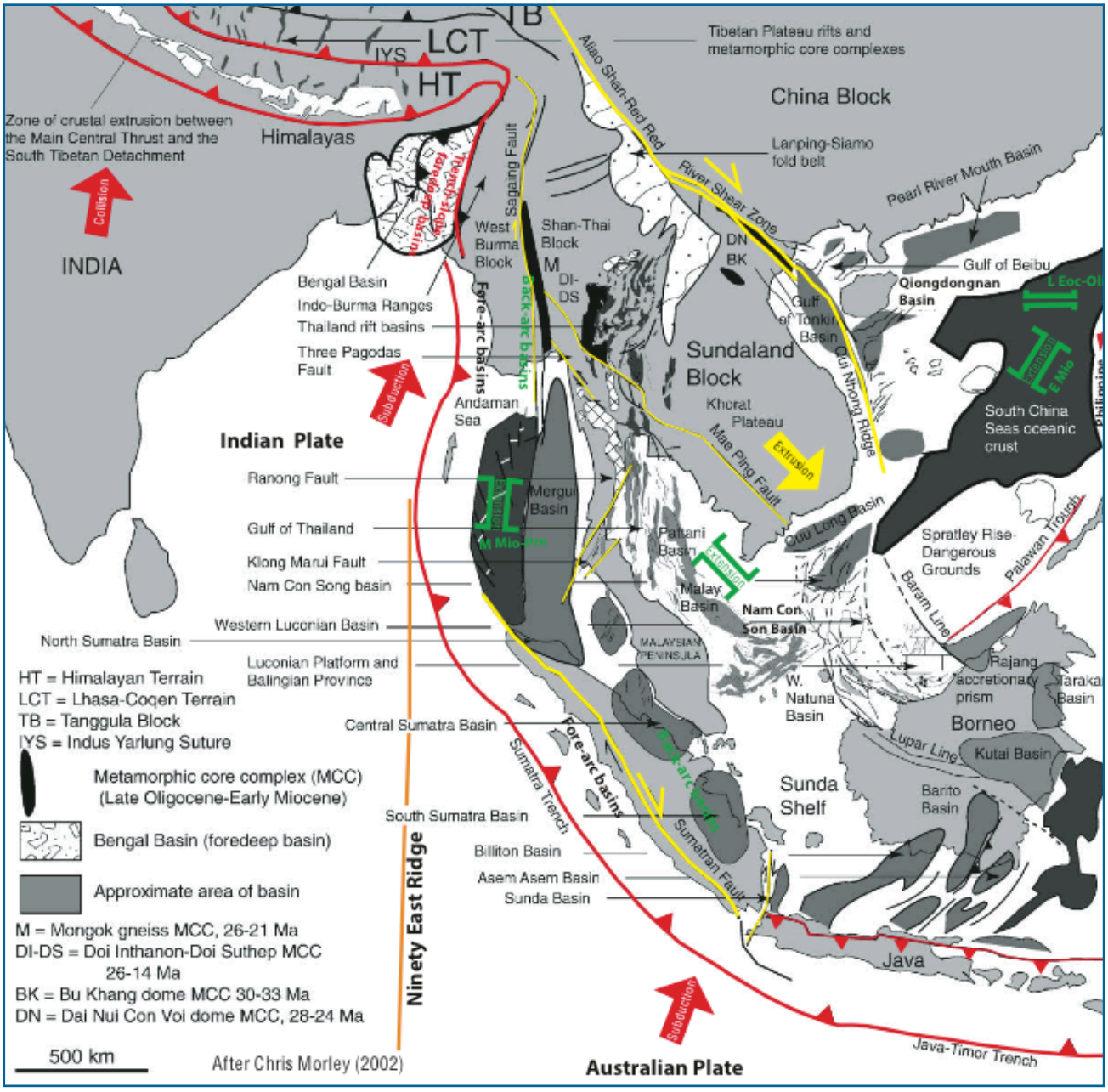

Figure 2 Tectonic framework of basins in SE Asia (Morley, 2012), showing basins in western SE Asia are located in back-arc, fore-arc to trench-slope, fore-deep settings from east to west.

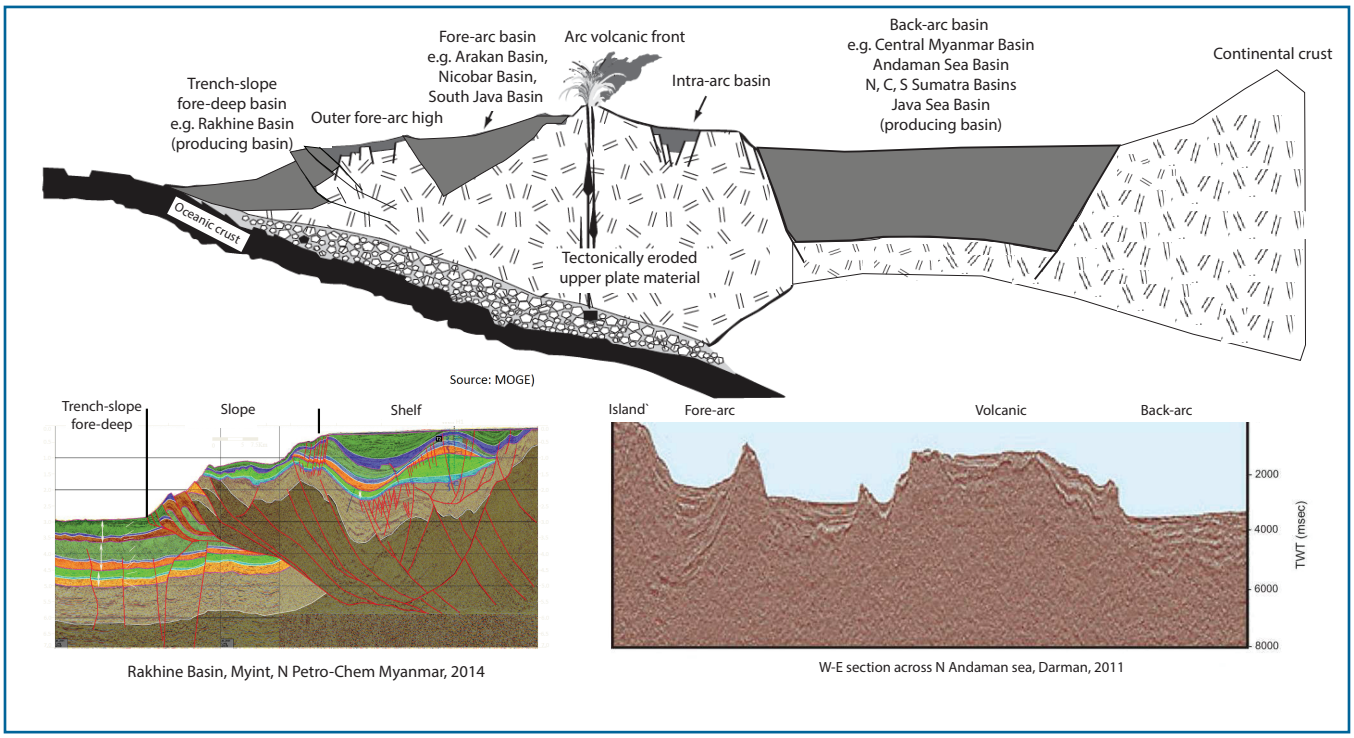

Figure 3 Basin types from active margin fore-deep trench to back-arc rift in western SE Asia and examples of seismic reflections for different types of basin.

In terms of prospectivity, Wood Mackenzie estimates that in SE Asia approximately 60.92 billion boe exist as commercial and technical oil and gas reserves, while total yet-to-find volume is estimated at 14.6 billion boe, of which liquids comprise 5.5 billion boe and gas 9.1 billion boe. The basins in central and eastern parts of SE Asia (Indonesia, Malaysia) have been successfully explored and are data-rich, producing basins, however, there are still many frontier back-arc, fore-arc and trench slope fore-deep basins that exists in western SE Asia i.e. Myanmar, Andaman Sea, West and South Indonesia (Figure 1, Table 1).

Myanmar is one of the least explored countries in SE Asia. Recent data from Myanma Oil and Gas Enterprise (MOGE) indicate that Myanmar is estimated to have 17.5 Tcf of gas reserves and 3.2 billion barrels of crude oil. Most basins in Myanmar are unexplored to underexplored, including offshore shallow water to deepwater trench slope Rakhine Basin, offshore Moattama, and Tanintharyi back-arc basins. The recent deepwater discovery of Shwe Field (4–6 Tcf of recoverable gas) in Rakhine Basin is the country's first offshore discovery since Yetagun gas field in the Gulf of Martaban 12 years ago. This shows huge deepwater potentials in the vastly under-explored deepwater basins in western SE Asia. So far, deepwater, new field wildcats only account for 13% of total drilling in the SE Asia region (Mair and Tan, 2015).

The Pre-Tertiary volcanic rocks are also an under-explored domain. The recent discovery from fractured basement in Sumatra indicates the huge potential of this play in SE Asia. Oil and gas exploration in SE Asia is being re-stimulated due to the drop off of liquids production and the rising demand for oil and gas in SE Asia, India and China. For Indonesia in western SE Asia, even though it has many well-explored traditional oil and gas producing basins, there are still large onshore and offshore areas that

remain relatively unexplored. For example, the fore-arc basins between the accretionary ridge and the volcanic arc from Myanmar to Java Island are frontier unexplored to underexplored basins. There is strong indication of working petroleum systems in the fore-arc basins based on gas discoveries in the Nias area. The commercial gas accumulation in the Pandora Gas Field in Papua New Guinea proved huge potentials in the fore-arc settings.

In addition to the need to assess the potential of the unexplored and underexplored basins, a re-evaluation of producing basins also need to be conducted to discover new plays in basins that are mature from an exploration perspective. A regional approach will help balance the data-rich area with the data-poor regions and results from data-rich areas can be used to infer petroleum system and exploration opportunities in data-poor basins having similar tectonic and depositional settings.

The differences between basins with different tectonic settings in western SE Asia also need to be addressed to study the different hydrocarbon accumulation habitats and find key geologic controls for a working petroleum system in different tectonic settings. From active subduction domains to back-arc domains in western SE Asia, the petroleum systems and reserves vary dramatically.

Most importantly, the basins in Myanmar area in the north have been influenced more by the eastern subduction of the Indian Oceanic Plate and Eocene-aged collision of India and Eurasia Plates. The basins in southern Indonesia e.g. Java area have been influenced more by the subduction of the Australian Oceanic Plate and Miocene to Recent aged northern movement of the Australia Plate (Figure 2). Previous studies e.g. Doust (2007) have addressed some common characteristics of petroleum systems on a regional scale, but the rift basins are very complex and all are variations on a common theme (Lambiase, 1994). In western SE Asia, these regional tectonic movements of different ages, local structural activities and polygenetic character of Cenozoic rift basins resulted in diverse source rocks and reservoirs and the variations of petroleum systems in time and space.

This research project area includes:

1. Onshore and offshore Myanmar;
2. Andaman Sea area;
3. Northern to southern Sumatra Basins and frontier basins to their west;
4. Basins in Java area (Figure 1 and Table 1).

The expertise and knowledge of EGI's researchers and reports from previous studies in SE Asia and basins with similar geology, interpretation, and integrated analysis from new data combined with previous data will make this high quality research project feasible. Sponsors will benefit from a prioritized list of potential exploration targets in both unexplored/underexplored basins and basins considered mature from an exploration standpoint. For companies that are not active in SE Asia, our systematic and comparative study will help help them use the knowledge learned from SE Asia as analogs for basin evolution and petroleum systems in other basins with similar tectonic settings.

Data Sources

Many EGI scientists along with collaborative partners in other countries have extensive knowledge of the regional geology and petroleum systems in SE Asia based on their previous industry and academic experience. EGI also completed several research projects in this region that focus on the tectonics and depositional history. An added uplift for this project is EGI's recently re-processed seismic data and unique well data in western SE Asia (Figure 1).

The data used for this study will include but not be limited to EGI's research archive, EGI's well and seismic data, EGI's previous studies, literature from multiple languages, theses, dissertations, data and research reports of multi-national institutes, data from consultants, etc., often not available with English translations. Data from sponsoring companies is not required for participation in this project however we do encourage data contributions to expand and enhance the goals, interpretations, and deliverables of the project. Sponsor data will be combined with EGI data to create comprehensive interpretations. Confidential sponsor data will be kept private and only interpretations will be made available to all sponsors as part of the project deliverables.

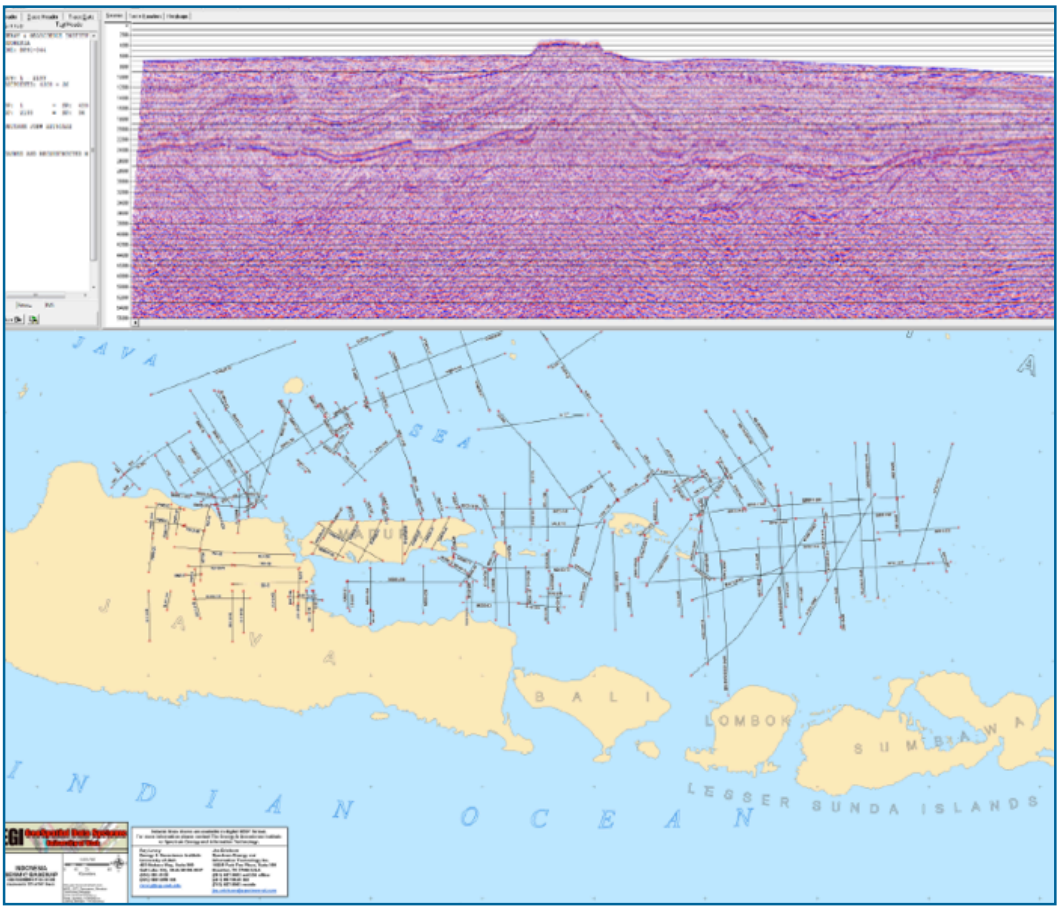

Figure 4 EGI's un-interpreted seismic data in the Java region, Indonesia

Deliverables

1. ArcGIS based database including regional tectonic and depositional maps, stratigraphic charts and stratigraphic cross sections for each basin and/or sub-basins, maps of Petroleum system elements and chart, modeled burial and thermal history and hydrocarbon migration and accumulation results, play maps, potential plays, examples and models for basins in trench-slope fore-deep, fore-arc and back-arc settings.
2. Interim data uploads (2 to 3) during the course of the research.
3. Meeting presentations and project report (both digital and hardcopy);
4. Reliable bibliographic database

Project Timeline, Report & Investment

The duration of the project will be 12 months, commencing as soon as signed contracts are received. Three project meetings (kick-off, mid-term and final) will be held during the project for progress reporting and discussions. A final report will be delivered after the final meeting. Investment per sponsor is anticipated to be $76,500 (USD).

Research Team

Staff	Expertise/ Affiliation
Shu Jiang, Ph.D., Principal Investigator	Regional study, Depositional Systems, Petroleum System & Reservoir Characterization (EGI)
Rasoul Sorkhabi, Ph.D.	Tectonics & Basin Evolution (EGI)
Raymond Levey, Ph.D., Director & Project Advisor	Basin-wide Geology & Hydrocarbon Accumulation (EGI)
Manas Pathak, Ph.D., EGI Affiliate Scientist	Basin Analysis & Petroleum Systems in Myanmar (Formerly EGI)
Christopher Kesler (B.A.)	GIS Mapping (EGI)
Dianshi Xiao, Ph.D., Associate Professor	Geochemistry, Basin Analysis & Petroleum Systems in Java (EGI Visiting Professor from China Univ of Petroleum at Qingdao)
Caifu Xiang, Ph.D., Associate Professor	SE Asia Geology & Regional Petroleum Systems
Xianglu Tang (Ph.D. Candidate)	Geological Mapping & Petroleum System Analysis in Indonesia (EGI Visiting student from China Univ of Petroleum at Beijing)
3 graduate students	Geological Mapping, Drafting, Data Mining

EGI Technical Contacts

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EGI Sponsorship & Contract Information

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Research Interests

- Petroleum geology for conventional and unconventional resources
- Geothermal geology
- Sequence stratigraphy
- Basin analysis
- Lacustrine to deepwater sedimentary geology
- Petroleum systems
- Reservoir characterization
- Lacustrine to deepwater depositional systems
- Seismic interpretation integration of geology, geophysics, geochemistry, and engineering

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May 8, 2018 4:35 PM

Shu Jiang, PhD

Research Associate Professor

Coordinator for China Program Development

Senior Research Scientist and Research Associate Professor Shu Jiang joined EGI in 2010. He earned his Ph.D. in Petroleum Geology from China University of Geosciences at Wuhan and completed postdoctoral research at the University of Colorado at Boulder He worked at CNOOC in Beijing for two years where he was involved in a significant gas discovery in Bohai Bay, China.

Shu has over 20 years experience in petroleum geology, sedimentary geology, basin analysis, sequence stratigraphy, petroleum systems, lacustrine to deepwater depositional systems, and unconventional reservoirs research spanning geology, geochemistry, geophysics and petroleum engineering. He is a Certified Petroleum Geologist (CPG), active member of AAPG, SEG, IAS, and GSA and has more than 90 publications to his credit. He also serves as an Advisory Member of the AAPG Shale Gas & Liquids Committee and has convened and chaired many international meetings.

Sequence Stratigraphy, Basin Analysis & Petroleum Systems for Conventional and Unconventional Reservoir Prediction

Shu conducts innovative and applied research in sequence stratigraphy and basin analysis in various tectonic settings by integrating core, well logs, seismic data, outcrop, etc. He proposes practical depositional models and suggest potential drilling targets for both conventional and unconventional reservoirs by integrating petroleum system analysis.

Lacustrine to Deepwater Depositional Systems

Shu's studies include the ancient and modern lacustrine to deepwater siliciclastic sediments transportation from source to sink and characterization of spatial and temporal evolution of depositional element architecture to predict deepwater reservoirs. Projects integrate structural, sedimentological and geomorphic studies and bridge both fundamental and petroleum geosciences.

Reservoir Description & Characterization

His work achieves successful reservoir model characterization by accurate property and architecture of all the siliciclastic depositional elements and uses state-of-the-art interpretation tools on a wide range of outcrop and subsurface data-sets to predict stratigraphic occurrence, 3-D geometry, and geophysical attributes of sandstone, CMB and shale reservoirs from lacustrine to deepwater setting.

Global Experience

Shu has worldwide industry and academic experiences from continental to deepwater setting basins (from East China lacustrine rifted basins, Northern China Cratonic basin, West China foreland basins, to South China Sea passive margin basin, basins in SE Asia, the Rocky Mountains, onshore Africa, and South America ,through deepwater GOM, Angola, Australia basins).