

PROCEEDING



4th INTERNATIONAL GEOSCIENCE CONFERENCE ON TIMOR - LESTE GEOLOGICAL RESOURCES DATA AND INFORMATION FOR ECONOMIC DIVERSIFICATION AND DEVELOPMENT

Dili, 23 - 26 October 2018



PROCEEDING

4th IPG International Geosciences Conference on Timor-Leste Geological Resources Data and Information for Economic Diversification and Development

Responsible

President of IPG, H.E. Helio Casimiro Guterres, M.Sc

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ACKNOWLEDGEMENT

Many people have made significant contributions to the development, organization and implementation of this conference, and they all deserve our acknowledgement and gratitude for their contributions. First we wish to thank H.E. Interim Minister of Petroleum and Mineral Hermenegildo Augusto Cabral Pereira and H.E. Vice Minister of Finance Sara Lobo Brites for their maximum support and contributions.

We also would like to thanks H.E. President of RDTL Dr. Francisco Guterres Lú-Olo, H.E Prime Minister of RDTL Taur Matan Ruak, H.E. Kayrala Xanana Gusmão, H.E. Designated Minister of Petroleum and Minerals Alfredo Pires, H.E. Minister of Agriculture and Fisheries Joaquim José Gusmão dos Reis Martins, H.E Minister of Public Works Salvador Soares dos Reis Pires and H.E. Former Minister of MRM Mariano Assanami Sabino for their presences and ideally thought about Timor-Leste Geological Resources Data and Information for Economic Diversification and Development.

Our sincere gratitude to the President of the Instituto do Petróleo e Geologia H.E. Helio Casimiro Guterres and organizing committee members for their thoughtful suggestions and contributions to the development of this conference.

This conference is supported by:



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Through this proceeding, the organizing committee wish to express our deep and sincere gratitude to the National and International speakers, Keynote speakers, and other individuals or organization which play support in achieving this 4th IPG International conference.

Organizing Committee

PRESIDENT OF IPG MESSAGE FOR THE CONFERENCE

Dear friends and colleagues,

We warmly welcome you to the **4th IPG International Geosciences Conference on Timor-Leste**. This is an important event, which will attract numbers of Timorese and international geoscientists. The Conference will be an excellent opportunity for scientists, engineers, managers and administrators from various countries and research institutions to share their research experiences, and recent achievements in geological, hydrocarbon, hydrology, mineral and hazard studies, within the context of economic diversification and development of Timor-Leste.

The theme of the conference this time will be **Timor-Leste Geological Resources Data and Information for Economic Diversification and Development**. This will emphasize new achievements in geosciences and their application to improve geological investigation of Timor-Leste resources, including prospecting, exploration, and exploitation and processing. The conference will also emphasize the importance of prediction, control, and mitigation, of, and adaptation to, geological hazards as contributions to the socio-economic development of nations facing impacts of the localization of the country in Ring of Fire position. The content of the conference will also introduce the scientific basis, and recommendations, for effective policy-making and governance needed to ensure economic diversification and development of Timor-Leste.

This conference will be held from 23th - 26th October 2018. The combination of scientific presentations, policy maker and government attendance, participation of academic science groups and the private sector will encourage better understanding on real geological subject, exclusively in the geological data and information, and its uses in supporting economic diversification and development of the country.

On behalf of the Instituto do Petróleo e Geologia (IPG), I warmly welcome you all and hoping that the conference will bring new ideas, new dreams and new geoscience spirit to look forward to the better life of our country.

“Where geological resources (oil, gas and minerals) really are ...???”

In the final analysis, are in our own head...”

Helio Casimiro Guterres

President of IPG

GREETINGS FROM PRESIDENT OF ORGANIZING COMMITTEE

I'm very delighted to welcoming you all to the 4th IPG International Geoscience Conference on Timor-Leste Geological Resources Data and information for Economic Diversification and Development, and may we wish the Blessing of Our Lord Jesus Christ be with us all today, therefore these four days conference is full of Grace of our Lord and the Blessing of Timor-Leste ancestor to this meeting in which will yielding a positive results for the development plan of this nation.

As the country Geological Research Centre, IPG hold various responsibilities as stipulated under the RDTL Government Decree Law No. 33/2012 of July 18 for studying, managing, storing, distributing, and analysing, Petroleum and Gas as well as Mineral resources, and Geological hazards data and information and maximizing its utilization for development of the nation with modern science and technology. This is a not an easy tasks, considering various challenging facing by the nations, nationally and regionally.

These tasks has enforce IPG to accelerate its activities within the last few years since its instalment, to initiated and conducted various collaboration works with many stakeholders, from private and public entities, worldwide, in carrying out research focus studying of geological resources of the country, including researching on geological risks around Timor-Leste territory. Some studies and surveys data that have been concluded is shared with many public agencies, government ministries, industry, academia, researchers, private entities and media, regulators and not to exclude the legislators. Although these Geological Data and Information is outstanding to become a key role in tackling the challenges of sustainable development, especially when the discussion is about the issue of land use, land degradation and also groundwater protection, the importance of Geological Data and Information for decision making in land-use and development planning is not fully appreciated by many key decision makers technically and politically and not merely happen in Timor-Leste but I fully believe in more industrialized country as well. Hence before it's become too late to be announced publicly, IPG has initiated severally international related talk with the one today, with a focus and attention to share only one visions of sustainability of Geoscience data & Information for integrated planning to reach more on sustainable development plan for this country.

The Conference of today, is set to embrace the think tanks professional's, & scholars in the field of Geosciences & Geology as a means to provide an informative news to a forum of academia, industry, regulators and researchers regarding challenges and opportunities of geoscience data & information in relation to economic diversification that give such a positive impact on economic

development in the long-run. During these four days discussions, it is expected to see and learnt more from the experts about the key roles of geoscientist & geologist in paving the way for sustainable development and poverty reduction planning. As a growing pressure on the government to spend less on most of its public Geological Surveys Organizations, the “actual value for money” spent on those services is increasingly under the investigation and debated. Of course by scrutinize the works of Geological Surveys as a public entities, in utilizing the public funds for data and information collection and transforming these data and information to affect better decision making processes for economic diversification and development, the doubt will be lessens.

Recent study by Booz and Allen Hamilton (and economic study of Gulf Cooperation Country (GCC) group, Group of Seven (G7) countries, and Transformation economies group country) endorses, that the sustainable economy improves a nation’s living standard by generating prosperity and employments, and boosting the growth of new knowledge and technology, and facilitating to guarantee a persistent political environment. Having varied economy, based on an extensive range of commercial sectors, has long been thought to play a key role in a sustainable economy. There is a sturdy connection flanked by economic diversity and sustainability, and economic diversification can decrease a nation’s economic instability and rise its real activity performance.

As a hydrocarbon rich country in which our economies heavily invested in oil and gas, Timor-Leste may encountered particularly daunting challenge in diversifying; consequently it is outstanding to define just how precarious economic diversity was to the creation of our sustainable economies. The Economic Diversification has to become our strategy in formulating our economy transformation agenda. Our Policy makers should ensure that Timor-Leste has a strong and sustainable economy, especially because we only rely on a single export commodity, therefore it is a must to focus our attention on economic diversification when creating our development agenda, in which should also be prepared to rigorously measure and monitor economic diversity in evaluating the success of the policies.

One of the main function of the national geological surveys organization is to provide national geoscience information services. Much of the required data is collected through mapping program. A detailed publicly available information concerning nature and origin of geology of an area is essential for inform public policy making and for economic development (Bernknopf et al., 1993). A clear assumption underpinning this works is that mapping, resulting in production of maps and associated databases, releases information, that can lead to significant and diverse economic and social benefits. The Detail Geological Data can lead to the prevention of various negative impact of development for different sectors of the society. Take an example, Ground Water Availability mapping, will enable

identification of direct and indirect contaminant factors affected human health leading to disease.

The 4th IPG International Geoscience conference, is held with the objective to analyses and seek for the answer of the real condition of when Geological Surveys Agency collect and process data to produce information. It is important to observe thoroughly at what to come about to these data and information once it ‘leaves’ the provider:

1. Whether the data and information can be easily accessed by end users, and
2. Whether the data and information produced is in an appropriate form to be used for ultimate political decisions makers, or
3. Whether the information is influentially affect the political decisions.

Although a growing pressure is continuously exist in understanding the works and contribution of Timor-Leste Geological Survey Agencies towards economic diversification agendas of the government, through these following conference thematic topics to be discussed in the days to come, hopefully the understanding of direct & indirect impact of its works will be improved. The only certain issue to be shared also here is a sustainable and strong citizens, consequently, depend on access to geoscience data & information and the expertise to interpret this, as well as meaningful engagement by the geoscience community.

To conclude let me take this opportunity to thanks the Organising Committee of the 4th IPG International Geoscience Conference, for the great effort done so far in preparing and initiated the works until today and the end of the Conferences. Even the preparation processes went through different disadvantages, but we are able to show our commitment being one in successfully implement the event. For that I should price you all.

I also would like to announce here that it is very unfortunate for us today to not have Professor Ron Harris to attend and participate in this conferences due to the accident he is encounter few weeks ago, during the Palu Tsunami event, in Denpasar Indonesia. But the conference have a numerous of Professors from Japan, Europe, and Australia, to give a colour for the conference, this is include, Professor Roberto Feinstein from Coimbra University, Professor Mike Sandiford from Melbourne University, Professor David Haig from Western Australia University and some more Professor that I may not able to mentioned here.

I hope you have an enjoyable and informative day, and go away with a better understanding of the Geological Resources Data Importance in sustaining economic diversification and development, the role of geologists in ensuring their

success, and how you can use your skills to support these, joining the actions of Diversifying Economic Agenda of Timor-Leste today and throughout your career.

Thank you

Jorge Martins Dasilaku, M.Sc.

**4th IPG International Geosciences Conference on Timor-Leste Geological Resources Data
and Information for Economic Diversification and Development
Dili, 23 – 26 October 2018**

CONFERENCE AGENDA

Date & Time	Programs	Responsible Person
22 Oct. 2018	International Guest Arrival	Organizing Committee Team
23 Oct. 2018	Conference Day 1 Governing Geological Resources for Timor-Leste Development	
07:30-08:30	Guest Arrival & Registration of Participants	Organizing Committee Team
08:30-08:50	Welcoming President, Prime Minister of RDTL and others special guest	IPG Management Team
09:10-09:20	Welcome Dance Performance	MC
09:20-09:25	National Anthem	All Participants
09:25-09:35	Remarks	President of Organizing Committee
09:35-10:00	Opening Ceremony & Remarks	H.E President of RDTL
10:00-10:10	Remarks	H.E Prime Minister of RDTL
10:10-10:20	Remarks	H.E Minister Interim of MPM
10:20-10:30	Remarks	H.E President of IPG
10:30-10:40	Photo Session (IPG team with Special Guest)	MC
10:40-10:50	Special Guest Visiting Exhibition	MC
10:50-11:10	Coffee Break	All Participants
11:10-11:25	Potency of Commodities Mineral in Timor-Leste	Elias da S. Cabral, Instituto do Petróleo e Geologia (IPG)
11:30-11:55	Permo Triassic Prospectivity Offshore Timor Leste and Adjacent Seas	Prof. Roberto Fainstein, Universidade de Coimbra
12:00-12:15	Timor-Leste; Geology and Geophysics Appraisal of the Southern Region Onshore and of the Adjacent Offshore Shallow and Deep-Water	Juvêncio D. C. do Rosario, Instituto do Petróleo e Geologia (IPG)
12:15-12:30	Q & A	All Participants
12:30-13:30	Lunch	All Participants
13:35-13:50	Geological Infrastructure as the Foundation for Future Resilience	Prof. Mike Sandiford, Melbourne University
13:55-14:10	Inspection as One of Key Tools in Ensuring Operator's Compliance With Applicable Laws and Regulations	José Sarmento, Autoridade Nacional do Petróleo e Minerais Timor-Leste (ANPM)
14:15-14:30	Sustainability of Groundwater Resources for Economic Development in Timor-Leste	Gustavo da Cruz, Direção Nacional de Gestão dos Recursos de Água (DNGRA)
14:35-14:50	Helping Timor-Leste Grow-Unlocking the Economic and Social Potential of Timor Leste's Minerals and Aggregates Industries Using Data	Ian Sinclair (Iron Fortune)
14:55-15:15	Coffee Break	All Participants
15:15-15:30	Timor-Leste Geological Resources Data and Information for Economic Diversification and Development in Parallel to the Timor-Leste Extractive Industry Transparency Initiative (TL-EITI)	Elda Guterres, Timor-Leste Extractive Industry Transparency Initiative (TL-EITI)
15:35-15:50	Academic Perspective of the Petroleum Industry in the Future	Custodio Assis C. Ximenes, Universidade Dili
15:55-16:15	Q & A	All Participants
16:15-17:00	Closing (Exhibition)	All Participants

**4th IPG International Geosciences Conference on Timor-Leste Geological Resources Data
and Information for Economic Diversification and Development
Dili, 23 – 26 October 2018**

Date & Time	Programs	Responsible Person
24 Oct. 2018	Conference Day 2 Geological Survey Data and Information for Economic Development of the Country	
08:30-09:00	Guest Arrival & Registration of Participants	Organizing Committee Team
09:00-09:05	Welcoming	MC
09:05-09:20	Remarks	H.E. Kayrala Xanana Gusmão
09:25-09:35	Remarks	Former Minister of MRM H.E. Mariano Assanami Sabino
09:40-09:55	Remarks	Francisco Monteiro, President of Timor GAP
09:55-10:20	The Geology and Petroleum Potential of Onshore Block B (Aituto-Bazol Area)	Dr. Timothy Charlton (Timor GAP)
10:20-10:35	Coffee Break	All Participants
10:35-10:50	The Geology and Petroleum Potential of Onshore Block A (Suai Area)	Debora Freitas (Timor GAP)
10:55-11:10	The Geology and Petroleum Potential of Onshore Block C (Betano-Same Area)	Maria Guterres (Timor GAP)
11:15-11:30	Crocodile 3D Broadband Seismic Processing and Interpretation Reveal Sub-thrust Prospects in Timor-Leste Offshore Area	Budi Priasati (Timor GAP)
11:35-11:50	Onshore Oil Exploration, Southwest Timor Leste	Jan Hulse, Timor Resources
11:55-12:10	Onshore Seismic - First Image of An Lolotoi Allochthon?	Mike Bucknill, Timor Resources
12:15-12:30	Q & A	All Participants
12:35-13:35	Lunch	All Participants
13:40-14:05	Key Stratigraphic Horizons for Assembling a Revised Tectonostratigraphic Framework for Timor-Leste	Prof. David Haig, University of Western Australia (UWA)
14:10-14:25	Maturing Ones Understanding on the Timor-Leste Onshore Petroleum and Mineral Resources Potentials Through an Application of the an Integrated Airborne Geophysical Surveys	Mateus da Costa, Autoridade Nacional do Petróleo e Minerais Timor-Leste (ANPM)
14:30-14:45	Petroleum System Elements Evaluation in Laga and Baguia Areas	Jose S. Nano, Instituto do Petróleo e Geologia (IPG)
14:50-15:05	Geochemistry Study of Black Shale in Baguia and Laga Areas	Lucia dos Santos, Instituto do Petróleo e Geologia (IPG)
15:05-15:25	Coffee Break	All Participants
15:30-15:45	Jurassic Reservoir and Source Potential in Timor-Leste	Eujay McCartain University of Western Australia (UWA)
15:50-16:05	Reconciling the Modeled Log and Core Based Saturation Height Functions: A Case Study from the Bayu Undan Gas-Condensate Reservoir	Ernesto Pinto, Autoridade Nacional do Petróleo e Minerais Timor-Leste (ANPM)
16:05-16:25	Q & A	All Participants
16:25-17:00	Closing (Exhibition)	All Participants

**4th IPG International Geosciences Conference on Timor-Leste Geological Resources Data
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Dili, 23 – 26 October 2018**

Date & Time	Programs	Responsible Person
25 Oct. 2018	Conference Day 3 The Sustainability of Geological Resource Management and Economics Development	
08:30-09:00	Guest Arrival & Registration of Participants	Organizing Committee Team
09:00-09:05	Welcoming	MC
09:05-09:15	Remarks	H.E. Minister of MAP Joaquim Jose G. dos Reis Martins
09:20-09:45	Quaternary Uplift and Deformation as Recorded by the Timor-Leste North Coast Baucau Limestone	Nicole Cox (Federation University Australia)
09:50-10:05	Tectonic Setting of Timor Derived from Seismological Study (A preliminary study)	Luis T. da Costa, Instituto do Petróleo e Geologia (IPG)
10:10-10:30	Coffee Break	All Participants
10:35-10:50	Geological Resources of Atauro Island (Preliminary Study)	Job Brites dos Santos, Instituto do Petróleo e Geologia (IPG)
10:55-11:10	Geology and Mineral Resources in Citrana Area, Oecusse-East Timor	Frederico C.M. da Costa, Instituto do Petróleo e Geologia (IPG)
11:15-11:30	Geological Characterization of the Maquelab-Oecusse Area by Integrating Field Data and Interpretation of Processed Landsat 8 Image	Victor A. de Sousa Vicente, Instituto do Petróleo e Geologia (IPG)
11:35-11:50	Manganese Exploration in Timor Island	Fabie Reza, Peak Everest Mining, Lda
11:50-12:10	Q & A	All Participants
12:30-13:30	Lunch	All Participants
13:35-14:00	Arc-Continent collision myths busted by Timor Leste tectonics	Prof. Ronald Harris, Brigham Young University (BYU) USA
14:05-14:20	The Structural Position of the Lolotoi Metamorphic Complex	Brendan Duffy (University of Melbourne, Australia)
14:25-14:40	ANPM ICT for Petroleum and Mineral Data	Dionisio Martins, Autoridade Nacional do Petróleo e Minerais Timor-Leste (ANPM)
14:45-15:00	Utilization of Drone Technology for Stockpiles Volumetric Calculation: A Case Study for Raiketan Production Site	Jose Joanico Freija de Jesus Soares, Autoridade Nacional do Petróleo e Minerais Timor-Leste (ANPM)
15:00-15:20	Coffee Break	All Participants
15:25-15:40	Integrating Geophysical Airborne and Geological Data to Characterize Karst Aquifer at Baucau Plateau, Baucau Municipality Timor-Leste	Moises Soares, Instituto do Petróleo e Geologia (IPG)
15:45-16:00	Geological Mapping and Groundwater Quality Analyses of Karst Aquifer in Baucau Municipality	Joaninha Belo Ornai (UNTL)
16:00-16:15	Hydrothermal Alteration and Mineralization of Aileu Formation	Nazario Gomes (DIT)
16:15-16:30	Q & A	All Participants
16:20-17:00	Closing (Exhibition)	All Participants

**4th IPG International Geosciences Conference on Timor-Leste Geological Resources Data
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Date & Time	Programs	Responsible Person
26 Oct. 2018	Conference Day 4 Economic Growth and Volatility in Geological Resources and Geo-Hazard	
08:30-09:00	Guest Arrival & Registration of Participants	Organizing Committee Team
09:00-09:05	Welcoming	MC
09:10-09:20	Remarks	H.E. Minister of Public Works, Salvador Soares dos Reis Pires
09:25-09:50	The Importance of Geospatial Information for Development	Dr. Asep Karsidi, Badan Pengkajian dan Penerapan Teknologi (BPPT) Geospatial dan Kebencanaan
09:55-10:10	Tsunami Modelling of Dili City	Luis T. da Costa, Instituto do Petróleo e Geologia (IPG)
10:15-10:30	Coastal Geo-Hazard Study Along North Coast of Timor-Leste	Oktoviano V. T. de Jesus, Instituto do Petróleo e Geologia (IPG)
10:35-10:55	Coffee Break	All Participants
11:00-11:15	Initial Study of Shallow Groundwater Quality By Using Some Physico-Chemical and Microbiological Parameters in Debos and Surrounding Areas-Suai Municipality	Marçal Ximenes, Instituto do Petróleo e Geologia (IPG)
11:20-11:35	Identification of Geotourism Potential: Touristic Zone of Oriental, Central and Occidental	Delio Manuel (USJTL)
11:40-11:55	Climate and its Impact on Timor-Leste	Terencio T.T. F. Moniz, Direcção Nacional de Meteorologia e Geofísica (DNMG) de Timor-Leste
12:00-12:15	Development and Application of Database System of Geological and Geotechnical Information	Prof. Hidehiko Kazama (JICA)
12:20-12:30	Q & A	All Participants
12:35-13:30	Lunch	All Participants
13:30-13:55	Great Eastern Sunda Arc Earthquakes & Tsunamis Recorded by Tsunami Deposits from west Java to Timor Leste	Prof. Ronald Harris (Brigham Young University, USA)
14:00-14:15	Concept and Design of IPG SDI's	Osorio Xavier da Costa, Director of Geo-Information System, IPG.
14:20-14:35	The Importance of Environmental Data Management and Dissemination as a Force for Measured, Rational and Sustainable Economic Development in Timor-Leste	Daniel Hunter, Cardno -Timor-Leste.
14:40-14:55	Slope Stability and Rockfall Hazard Analysis along Karimbala Road, Liquiça Municipality, Timor-Leste	Oktoviano V. T. de Jesus, Instituto do Petróleo e Geologia (IPG)
14:55-15:15	Coffee Break	All Participants
15:20-15:35	A Microtremor HVSr Study for the Estimation of Seismic Site Effects in the Capital of Timor-Leste	Felix J. G. Jones, Instituto do Petróleo e Geologia (IPG)
15:40-15:55	A Case Study Conducted on Aituto Landslide	João Pedro, Direcção Nacional de Estradas, Pontes e Controlo de Cheias
15:55-16:15	Q & A	All Participants
16:15-16:25	Signing the Transfer of Title Form	Between UNDP & IPG (MPM)
16:30-16:40	Remarks	Alfredo Pires (Designated Minister of Petroleum and Minerals)
16:40-16:50	Closing Ceremony	H.E. President of Parliament
16:50-17:00	Closing (Exhibition)	All Participants

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**CONFERENCE DAY 1 - GOVERNING GEOLOGICAL
RESOURCES FOR TIMOR-LESTE DEVELOPMENT**

POTENCY OF COMMODITIES MINERAL IN TIMOR-LESTE

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ABSTRACT

Geological formation of Timor-Leste formed by Pre-Permian Volcanic rocks, Permian Metamorphic rocks and volcanic rocks showed by Maubisse Basalt, Tertiary volcanic rocks, Triassic to Tertiary limestone that have been crystalized, Quaternary limestone, also sedimentary rocks and sand deposited on the main rivers in north and south part of Timor-Leste. The mineralization of the metallic minerals in Pre-Permian to Tertiary volcanic rocks can be occurred by emplacement process and alteration by intrusion of volcanic rocks which is formed the volcanic massive sulphide. Commonly mineral resources occurrence in Timor-Leste, classified in to metallic minerals, and non-metallic minerals. Metallic mineral composed by Iron, Chromium, Manganese, titanium, Au, Ag, Cu, heavy minerals and the others metallic minerals. Non-metallic minerals dividing in to three groups such as Industrial Minerals, Ornamental rocks and Industrial Rocks. Industries minerals composed by Bentonite, Phosphate, Gypsum, Kaolinite and Clay. Ornamental rocks composed by Marble, Marbleised Limestone and Serpentine. Industrial Rocks composed by Limestone, Gabbro, basalt, sand and gravel. The association of the mineral metallic identified in to Mineral associated with the Ultrabasic rocks and serpentinite are Nickel and chromium, copper mineral (Cu) associated with mafic rocks presented by the mineral Bornite, Chrysocolla, Cuprite, Azurite and Malachite, and alteration of massive sulphide are Au, Cu, Ag and Co.

Keywords: Metallic and non-metallic mineral, Commodities.

**TIMOR-LESTE; GEOLOGY AND GEOPHYSICS APPRAISAL OF THE
SOUTHERN REGION ONSHORE AND OF THE ADJACENT OFFSHORE
SHALLOW AND DEEP-WATER**

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ABSTRACT

The Southern region of the Timor-Leste micro-continent is characterized by an accretionary wedge resulting from the collision structuring caused by the north-western motion of the Australian Plate launching towards the Far-East Archipelago. This appraisal study thesis briefly reviews this plate tectonics scenario and is focused on the G & G investigations of data from wells drilled in southern Timor-Leste merged with interpreted data of recent seismic data gathered in the offshore areas. The regional litho-stratigraphy correlation between several wells of Banli-1, Cova-1, Jahal-1 and Baleia-1 was correlated in the southern onshore, Timor Trough, Sahul Syncline, Laminaria High until Flamingo High indicating in the Jurassic and Triassic the rock units of shales as a source rock or seal, the sandstone units as a reservoir rock and claystones as seal. These play units were ranging from Triassic to Lower Cretaceous in age.

Several horizons boundaries were interpreted from seismic amplitudes these are Seabed, Miocene, Cretaceous carbonates, Jurassic break-up unconformity, Triassic carbonates and the Permian carbonates. Seismic interpretation also identified several regional structuring bound by listric normal faults, thrust fault imbricates, folds, horst and graben, plus chaotic blocks. Seismic interpretation of the regional lines un-covered multiple attractive, Mesozoic and Palaeozoic, prospects in the offshore deep-water region these, if drilled successfully, may impact very favourably on the economy of Timor-Leste. In the offshore area, this thesis also addresses the outlook for future activities in the Greater Sunrise Gas Region and in the Timor Gap oil province particularly the prominent Bayu-Undan and satellite features. By contrast with the deeper offshore, the regions of southern Timor-Leste onshore and adjacent shallower waters still need substantial additional studies in order to enhance its seismic and drilling risk exploration.

Keywords: Regional G & G Appraisal, Seismic and Well Interpretations, Petroleum Geology, Future Outlook.

GEOLOGICAL INFRASTRUCTURE AS THE FOUNDATION FOR FUTURE RESILIENCE

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ABSTRACT

In many cultures the founding narratives that give reason to our lives originate in ancestral relationships with the land and, through that, the geology that underpins landscape. The Timorese crocodile legend speaks to a youthful rugged landscape only recently emerged from the sea. Our understanding of Timorese geology tells a very similar story, and pre-empts an important parallel narrative for any government that strives to establish national resilience. As a resource-rich nation set in a dynamic tectonic environment, government must balance the geological opportunity with the geological threat, and so an ambition to realize resilience requires will rest with an understanding of its geological heritage. In this talk I will outline what I see as some of the key elements that might be considered as an essential part of the geological infrastructure needed to achieve national resilience in terms of three distinct, but related goals, namely 1) Encouraging Appropriate Resource Development, 2) Ensuring Optimal Nation Building, and 3) Securing Community Safety.

Governments arguably most effectively encourage resource development through development and provision of appropriate pre-competitive data such as geological maps and regional geophysical and geochemical datasets. Optimal cost effective planning for nation-building projects, such as roads, airports, power grids or even down-town buildings, requires a geotechnical framework of rock behavior, site response, slope stability and erosion and flood vulnerability. Finally, both nation-building projects and community safety require an understanding that the threats played out by earthquakes, tsunamis, landslides and floods (and droughts), while inherently unpredictable, are all experienced through specific landscape responses (including groundwater). I will make the case that the essential pre-determinant for all three goals is a comprehensive national geological mapping infrastructure.

INSPECTION AS ONE OF KEY TOOLS IN ENSURING OPERATOR'S COMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS

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ABSTRACT

Autoridade Nacional do Petróleo e Minerais (ANPM) is a Public Institution established through Decree Law no. 20/2008 and amended through DL no. 1/2016. One of its functions as a regulatory authority for petroleum and mineral sectors to ensure strict compliance with Petroleum Activity Laws, Petroleum Mining Code, Timor Sea Treaty, Offshore Petroleum Operations in Timor-Leste Decree Law and other Timor-Leste's applicable laws and regulations to be established in the future. To fulfil its mandate ANPM oversees the following aspects of petroleum and mining operations, i.e. technical, health safety and environment, commercial, local content, etc. This presentation will provide a broad overview on ANPM exercising its regulatory functions in HSE, with particular focus on environmental inspection. The environmental inspection is carried out as one of the scopes or focuses of health, safety and environmental inspection. One of the main tools implemented by the ANPM, as the regulatory authority, to ensure that operators comply with environmental laws and regulations, ANPM carries out compliance monitoring through onsite inspection by qualified inspectors and by reviewing information and regulatory documents submitted by the operator. Compliance monitoring/inspection is carried out in each of all petroleum phases i.e. exploration, drilling, development and production, and decommissioning. This onsite inspection is normally carried out to facilities, such as seismic vessel, mobile offshore drilling unit (MODU), floating storage and offloading unit (FSO), production facilities and supporting vessels such as platform supply vessels, accommodation support vessel, construction and installation vessels, helicopters etc. This presentation is intended to highlight the inspection objectives and focus, type of inspections, inspection process, and methodology, and provided the number of inspection being carried out during the last 5 years, and provided some data on environmental findings (in terms of noncompliance and non-conformance) and the corrective action plans.

SUSTAINABILITY OF GROUNDWATER RESOURCES FOR ECONOMIC DEVELOPMENT IN TIMOR-LESTE

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ABSTRACT

Groundwater is a vast resource which greatly exceeds all of the water found in rivers, lakes and wetlands and most accessible water for many communities in Timor-Leste. The main water resources in Dili are the Comoro River with groundwater production capacity is estimated at 37,700m³/d. Groundwater in the Dili's aquifer is recharged by rainwater during the rainy season from December to March which total annual rainfall ranges from 1000mm -2000mm. The quality of groundwater based on Dili monitoring well data is around 500-900 uS/cm which is fresh water. Salty groundwater exists in alluvial aquifers due to the factors of; low rainfall, small catchments, salt in the surrounding rocks, high evaporation, connection to the sea, such as Tasitolu (>1000 uS/cm). Groundwater sources are limited and vulnerable to climate change such as el-nino and la-nina, groundwater extraction, sea water intrusion, waste water discharged in urban area, bacteriological contamination, change in terraces and population density. The legal framework on water resources that has not yet been approved as an obstacle to groundwater management. To ensure the sustainability of groundwater, it is necessary to manage water resources in order to promote the water planning and development, coordination, protection, conservation of water resources for human life, for economic development and also for ecosystem survival.

Keywords: Groundwater, Dili Aquifer, quality and quantity, challenges, water resources management

**HELPING TIMOR-LESTE GROW-UNLOCKING THE ECONOMIC AND
SOCIAL POTENTIAL OF TIMOR-LESTE’S MINERALS AND AGGREGATES
INDUSTRIES USING DATA**

Ian Sinclair
Iron Fortune

ABSTRACT

GeoScience Victoria, formerly the Geological Survey of Victoria (both referred to as “GSV” in the paper) is a government agency responsible for mapping the geology of Victoria, a state located in the southern part of Australia.

The Geological Survey was founded in the 1852 in the Victorian gold rush era, and proceeded to actively explore the state of Victoria for geological and mineral resources, discovering and mapping extensive gold, brown coal and petroleum resources.

GSV has successfully studied and mapped the geology of Victoria for more than 160 years, providing pre-competitive geoscience information to explorers, existing tenement holders and the public. GSV undertakes projects and programs in three areas - regional geological investigations, mineral and energy resource and prospectivity assessments and geoscience information management.

Geoscience information, including Exploration and Mining License reports, minerals, petroleum and other data are made freely available to the public through download or printed reports.

This paper will outlined how data is acquired, shared and used, and provide recently examples including the Stavely Project. This project is a collaboration between Geoscience Australia and GSV. The Stavely Project initiative seeks to address the challenges of 'greenfield' exploration in under-cover areas in Australia through the acquisition and provision of pre-competitive fundamental geoscience data and concepts to exploration and mining companies.

**TIMOR LESTE GEOLOGICAL RESOURCES DATA AND INFORMATION
FOR ECONOMIC DIVERSIFICATION AND DEVELOPMENT IN PARALLEL
TO THE TIMOR-LESTE EXTRACTIVE INDUSTRY TRANSPARENCY
INITIATIVE (TL-EITI)**

Elda Guterres da Silva
Timor-Leste Extractive Industry Transparency Initiative (TL-EITI)

ABSTRACT

The EITI is the global standard for the good governance of oil, gas and mineral resources. When implemented by Timor-Leste, it is designed to improve accountability and public trust for the revenues paid and received for a country's oil, gas and mineral resources, how a country's natural resources are governed. This ranges from how the rights are issued, to how the resources are monetized, to how they benefit the Timor-Leste citizens and the economy development to ensure optimal use of public resources work on economic modelling.

Timor-Leste oil, gas and minerals sector is already our greatest source of State Budget revenue that used to diversify in national economic development for our people and our nation. This commitment has been demonstrated a Special Investment Agreement with TL Cement, as well as adhering to international transparency mechanisms such as the Extractive Industries Transparency Initiative (EITI).

The overview of the NEW EITI Standard below, including links to more information, data information has been a point of focus in the national. While multi stakeholder group also focus on the availability of large companies databases, the Open Government Partnership (OGP) and other promote data as part of opening up government systems as a means to enable accountability. In parallel to this, the National and International Extractive Industry Transparency (EITI)

For TL-EITI, is still a very abstract concept that data information which is accessible, a more precise definition than available, it also simples immediately or continuously available for anyone who wishes to explore the information (EITI Principles 2016).

The TL-EITI has come a long way on data extract, by continuously building a TL-EITI database for summary data of TL-EITI Reports, is the beginning of the National and International database, but the policy also mandates that the data information and polices for such be created on the nation level. This paper seeks to identify the various challenges and opportunities of data in TL-EITI, and how TL-EITI can work with the all institution to promote open data access for the Timor-Leste exploring the inclusion of solid mineral (the mining sector) at a later time.

Timor-Leste one of the countries implementing the EITI Standard publish TL-EITI Reports, that disclose the revenues and other information on the extractive sectors of these publications, companies report payments to government (taxes, royalties, fees, etc) and the government reports what it has received.

This paper identifies and discusses some key opportunities and challenges of data information in the Timor-Leste context.

Keywords: TL-EITI can work with the all institution to promote and data access.

**CONFERENCE DAY 2 - GEOLOGICAL SURVEY DATA AND
INFORMATION FOR ECONOMIC DEVELOPMENT OF THE
COUNTRY**

THE GEOLOGY AND PETROLEUM POTENTIAL OF ONSHORE BLOCK B (AITUTO-BAZOL AREA)

Dr. Timothy Charlton*, Debora Freitas*, Maria Guterres*, Dino Gandara* and Norberta
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*TIMOR GAP Onshore Block

ABSTRACT

The Block B petroleum exploration area has not yet been gazetted as a full PSC, but TIMOR GAP currently hold exclusive petroleum exploration rights through Governmental Decree, and it is expected that the block will be turned into a third PSC contract area in joint venture with one or more partner companies in the near future. The block is centred around Bobonaro village, extending westward to Maliana, and eastward to Ainaro. Block B occupies an internal part of Timor Island, with very rugged mountainous terrain in which the negative of difficult access is balanced by the positive of greater geological exposure.

The two features of primary petroleum exploration interest in Block B are the Bazol and Aituto Anticlines. The Bazol Anticline was originally mapped by Audley-Charles (1968) as a WSW-ESE trending structural feature with numerous associated gas seeps, but with an exposed core of Permian rocks, suggesting that any prospectivity in the anticline had been lost by breaching. Our preliminary field studies, however, suggest that the anticline actually trends ENE-WSW, and that the core of the structure exposes rocks only as old as Middle/Late Triassic, suggesting the potential for prospectivity at the Permian level in the core of the anticline.

The Aituto Anticline to the NE of the Bazol Anticline trends WSW-ENE over a distance of about 35km. As with the Bazol Anticline, the Aituto Anticline is cored at outcrop by Middle/Late Triassic rocks (limestones of the Aitutu Formation), and again the structure is interpreted to have potential prospectivity at the Permian level. During our 2017-2018 fieldwork we have identified a number of additional oil and gas seeps on the southern flank of the Aituto Anticline west of Ainaro. The prospectivity of the Aituto Anticline was recognised by Timor Oil in the late 1960s, and was proposed as their next onshore drilling target had not the political problems of the mid-1970s terminated Timor Oil's exploration activity.

Although both the Aituto and Bazol Anticlines are geologically encouraging exploration structures, it may prove difficult to assess their prospectivity through standard seismic-led exploration. It might be more cost-efficient to assess the prospectivity through less conventional means such as satellite mapping of natural hydrocarbon seeps, which appear to be abundant in association with both anticlines. While relatively high risk structures, the anticlines also have very large upside potential: the Aituto Anticline is, for instance, very similar in size (as well as in general geological setting in an arc-continent collision zone) to the giant Hides gas field in Papua New Guinea, which is

currently under development for LNG despite a much more challenging physical environment in central PNG in comparison with the more benign setting of central Timor-Leste.

THE GEOLOGY AND PETROLEUM POTENTIAL OF ONSHORE BLOCK A (SUAI AREA)

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*TIMOR GAP Onshore Block

ABSTRACT

Onshore Block A is a petroleum exploration area (PSC TL-OT-17-08) centred around the town of Suai in the SW of Timor-Leste. The block is operated by Timor Resources in 50:50 partnership with TIMOR GAP. Since May 2017 the TIMOR GAP Onshore Block geological team, in collaboration with Timor Resources, have been undertaking reconnaissance geological mapping of the entire Block Area, and integrating the new field geological data with an extensive database of pre-existing petroleum exploration results (well, gravity and seismic data together with geological reports) acquired in the area by Timor Oil Ltd. during the period 1958-1973.

Timor Oil drilled 16 exploration wells in the Suai area between 1960 and 1973, nine of which encountered significant hydrocarbons. Two (Matai and Cota Taçi) can be considered as sub-commercial discoveries, having flowed oil to the surface under test. Timor Oil also identified three natural oil seeps, and our fieldwork has added an additional 17 natural/water well seeps, 4 primarily of oil and 13 primarily gas, some with associated oily iridescence.

Petroleum exploration plays occur in two distinct types in Block A. In the late Neogene Suai Basin the Viqueque Formation contains potential reservoir sands interbedded with sealing shales, with possible trapping structures including simple anticlines, fault-controlled structural traps, and stratigraphic pinchouts. These are shallow geological features, and although probably forming relatively small exploration targets, they should be well imaged by the vibroseis seismic data due to be acquired across the area in late 2018. Deeper trapping structures are also likely to be present in the fold and thrust belt below and to the north of the Suai Basin, and although our fieldwork has delineated a number of potentially promising anticlinal structures, firm identification of exploration prospects at these deeper structural levels will probably need to await dynamite-based seismic acquisition at a later stage of exploration.

THE GEOLOGY AND PETROLEUM POTENTIAL OF ONSHORE BLOCK C (BETANO-SAME AREA)

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Charlton*

*TIMOR GAP Onshore Block

ABSTRACT

The Onshore Block C petroleum exploration area (PSC TL-OT-17-09) extends from north of Samé town to the south coast of Timor-Leste east and west of Betano village. As with Block A (Suai area), the PSC is operated by Timor Resources in 50:50 partnership with TIMOR GAP. Since May 2017 the TIMOR GAP Onshore Block geological team, in collaboration with Timor Resources, have been undertaking reconnaissance geological mapping of the entire Block C area, and integrating the new field geological data with the more limited exploration data acquired in this area by Timor Oil Ltd. during the 1960s and early 1970s. Timor Oil only drilled two wells in the Block C area (Betano-1 and Betano-2), with minor oil encountered in Betano-2.

Very little geological work has been undertaken in the Block C area since the Timor Oil-funded regional mapping of Audley-Charles (1968). We have produced a new geological map of the entire Block C area at a nominal scale of 1:100,000. This shows many features in common with the previous mapping, but also some notable differences:

- Extensive development of the Permian Maubisse Formation in the SW of the block (no Maubisse Formation was shown in this area on Audley-Charles's map). This includes several bodies of felsite igneous rocks north of Hatoudo which are undated but most likely Permian.
- Extensive outcrops of the Cretaceous-Paleogene Haulasi Formation on the southern slopes of the Bubususo metamorphic massif north of Samé (not mapped by Audley-Charles, but recognised, for instance, by Carter et al., 1976; and Standley & Harris, 2009). Although the Haulasi Formation is widely considered part of a non-Australian allochthonous succession, dinoflagellate genera and species identified in samples collected by Timor Resources include forms found in Cretaceous successions drilled in many wells on the Australian margin to the south of Timor, perhaps favouring an Australian-margin, non-allochthonous origin for this succession.
- A small but beautifully exposed volcanic/clastic succession east of Samé that is probably correlative of the Paleogene (?) Barique Formation (based on an apparent stratigraphic position between the Haulasi Formation and the Eocene Dartollu Limestone). This succession needs future detailed study.

In terms of petroleum exploration, five primary exploration leads were identified prior to the new fieldwork, three corresponding to large Bouguer gravity lows (interpreted pre-fieldwork as potentially corresponding to inversion anticlines) and two intervening gravity highs (potentially horst blocks between the inverted basinal lows). Our fieldwork

significantly downgraded the western structure because, although it was correctly identified from remote sensing data as an anticline, the core is breached down to the Permian Maubisse Formation. The western of the two horst block highs was also breached to basement, so this structure can also be discounted. However, the two remaining gravity lows remain strong candidates for potentially large and prospective inversion anticlines. In particular our mapping indicated a domal structure associated with the central gravity low, in an area where several natural oil seeps are also known. Furthermore, our fieldwork also identified a new anticlinal structure in the Aiassa river to the SW of Samé, and this may form a further exploration lead to be assessed by vibroseis seismic due to be acquired across the block in late 2018.

CROCODILE 3D BROADBAND SEISMIC PROCESSING AND INTERPRETATION REVEAL SUB-THRUST PROSPECTS IN TIMOR-LESTE OFFSHORE AREA

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*TIMOR GAP Offshore Block

ABSTRACT

A new 3D acquisition has been carried out by TIMOR GAP over the PSC block TL-SO-15-01 in Timor-Leste Offshore Area (TLOA). The PSC block is part of the Banda Arc petroleum province and located in a proven hydrocarbon province of the Plover Formation.

This survey area is characterized by a complex geological setting, including rugose seabed topography, fold–thrust, anticlinal and faulted structures with strong associated lateral velocity heterogeneity and seismic anisotropy. The main reservoir target is the Upper Jurassic Plover Formation, located at 850m-2400m below mud line (BML). Vintage seismic data shows the target reservoir was highly distorted due to the complex overburden and strong lateral velocity variation. Therefore, improving the bandwidth and signal to noise of this new seismic dataset and resolving the structural complexity became the main objective during the processing phase.

In this paper, we demonstrate the advanced technologies of seismic processing and imaging tools to deliver a high quality image and the data interpretation result. Broadband seismic processing provided the expanded bandwidth in particular, the ultra-low frequencies for coherency and continuity enhancement of the target level beneath the complex overburden. A TTI model building and depth imaging workflow uses geological constraints within the iterative common image point (CIP) tomography to resolve the spatial velocity heterogeneity and seismic anisotropy in the data. The application of these processing technologies was seen to collectively improve the interpretability of the image of the sub-thrust prospects.

The new broadband dataset allows interpretation of more than 30 individual closed seismic structures at various geological levels, stacked vertically, in 17 geographically distinct locations. The identification of prospects in the Triassic and Permian formations provide an unrecognized exploration fairway for explorations in the region. To date many prospects and exploration plays have all been found the Jurassic formation.

ONSHORE OIL EXPLORATION, SOUTHWEST TIMOR-LESTE

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Timor Resources

ABSTRACT

Timor Resources, a privately-owned energy exploration company, as Operator with partner TIMOR GAP, was granted Production Sharing Contracts TL-OT-17-08 and TL-OT-17-09 (referred to as Block A and C) with an effective commencement date of 27th June 2017.

The investment was made based on the recognition of a working petroleum system as evidenced by numerous oil and gas seeps and recoveries in Wells. It is estimated that 10,000bbl of oil was recovered from shallow holes and pits in the Matai area in the last century. The exploration work programme for the first licence year was focused on accessing geoscientific data and conducting geological field surveys with associated analyses of collected samples. Risked Play concepts and maps were derived to direct the subsequent work programme.

For various reasons, including the disrupted recent history of Timor-Leste, some potentially valuable work and data is not available or cannot be located. Significantly, the Operator was able to obtain the original seismic data files from the 318km 2D seismic survey (“SBT94”) conducted by Elnusa for Pertamina in 1994. The seismic lines were acquired using explosive sources in the Southern portion of Blocks A and C between Tilomar in the west and Betano to the east.

The SBT94 seismic lines were submitted to Velseis Processing and re-processed using modern techniques including velocity and statics modelling, noise attenuation and post/pre-stack time migration. The re-processing resulted in a significant improvement in image quality. To extract the maximum amount of information from the data the lines were then submitted to Geomage, a company specialising in the processing of data with complex geological structure and rugged topography.

The re-processed 1994 seismic data was combined with scanned onshore seismic data (1969-70) and the available offshore seismic lines. Interpretation of the seismic data was conducted for Block A in conjunction with geology, Well data and regional datasets (including ground gravity, elevation models and aerial/satellite imagery).

After interpretation of the data several leads were identified, and the Operator entered a competitive tender process to engage a seismic acquisition company to conduct an operation in its tenures. The successful bidder was BGP Inc. and the survey is currently in progress. The results of the seismic survey are intended to provide improved definition of targets which are proposed for a drilling campaign in 2019. Conceptual Well designs and well hazard analysis have been produced for nominal drilling locations.

ONSHORE SEISMIC - FIRST IMAGE OF AN LOLOTOI ALLOCHTHON?

Mike Bucknill
Timor Resources

ABSTRACT

The nature of the collision zone between Australia and Timor is an ongoing debate. Offshore seismic clearly images the Pliocene to Holocene synorogenic sedimentary basins which have limited extent onshore, where they are underlain to juxtaposed by Mesozoic sediments.

The relationship of the Lolotoi metamorphic massif to Mesozoic sediments is inconclusive due to challenges of complicated stratigraphy and dating, and poor clarity of contacts. The Lolotoi massif has been proposed as either autochthonous or allochthonous, which is significant to the geological evolution of Timor, and commercially significant if prospective hydrocarbon traps exist beneath the proposed allochthonous wedge.

Several wells have penetrated the Lolotoi at depths up to ≈ 2800 mSS, up to 600 metres thickness has been drilled, but no wells have penetrated through. Until now no seismic data has contributed to an understanding of the relationship. Reprocessing in 2017 by conventional workflow improved imaging of the coastal synorogenic basins, and demonstrated coherent energy in the Mesozoic section, with insufficient clarity to interpret reliably. Timor Resources was sufficiently encouraged to seek specialty processing capable of addressing these challenges, and selected Geomage, whose Common-Offset Multi-Focus (CO-MF) processing is a different technical solution which has many successful examples.

Imaging has improved beyond expectations, which has been interpreted in integration with surface geology mapping, wells, offshore seismic and gravity, to provide the first insight and possible resolution of the autochthonous versus allochthonous debate.

With an estimated thickness of ≈ 1200 metres in the area of interest, drilling is proposed to test the model. Fortuitously this is the crestal position of a large anticline with closure in the range 60 to 90 km² and providing an attractive commercial target.

KEY STRATIGRAPHIC HORIZONS FOR ASSEMBLING A REVISED TECTONOSTRATIGRAPHIC FRAMEWORK FOR TIMOR-LESTE

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Introduction

A revised tectonostratigraphic framework for Timor Leste is presented (Fig. 1; following Haig et al. under review). This has been established through a combination of fieldwork since 2003 and ongoing lithostratigraphic, microfacies and biostratigraphic analyses (based on foraminifera, palynomorphs, conodonts and radiolaria) in order to determine age and depositional environment of disjunct outcrop. These studies have been done in conjunction with similar studies of coeval strata in Western Australian basins, and comparison to equivalent-age strata in Indonesia and South-East Asia.

The uppermost Miocene to Holocene Synorogenic Association includes deposits of Phases 2–4 of the collision between the Australian continent and the volcanic Banda Arc (Fig. 1). These deposits accumulated as the present-day island of Timor formed. Phase 1 of collision (during the Late Miocene) is represented by a hiatus in deposition. A distinct difference in deformation style and degree of sediment diagenesis is apparent between the relatively undeformed Synorogenic Association and the deformed older rock units.

The Timor–Scott Plateau Association (T-SPA; Late Jurassic–early Late Miocene) and the East Gondwana Interior Rift Association (EGIRA; Late Carboniferous– Middle Jurassic) outcrop in close proximity (in some areas in alternating thrust sheets) and represent deposits present on the pre-collision Late Miocene Australian continental margin. A similar, but undeformed, stratigraphic succession is present today on the northern part of the Australian North West Shelf.

The Overthrust Terrane Association (OTA) includes Gondwanan/island arc/ocean crustal fragments that were emplaced in the Late Miocene over the north-west Australian continental margin during collision. Units of diverse origin ranging in age from the Early Jurassic to the Early Miocene are included in the Association. They differ lithostratigraphically from coeval units in T-SPA and EGIRA, and are present in coherent areas of outcrop (Fig. 1, insert map).

In designating each pre-collision stratigraphic unit, a "group" is used rather than "formation". Because of the extremely dislocated nature of the stratigraphic successions, the "Stratigraphic Guide" of the International Commission on Stratigraphy (at www.stratigraphy.org) cannot be followed based on present knowledge because stratigraphic contacts between units and/or continuous stratigraphic sections through units are rarely found. The broad "groups" are mappable units with distinctive characters, particularly fossil assemblages (i.e. the biogenic sediment component is diagnostic of each unit). In future, it may be possible to recognize finer lithostratigraphic units in some of the broad "groups" (e.g. "formations").

The time scale used here is that of Cohen et al. (2018). It is the official time scale of the International Commission on Stratigraphy (www.stratigraphy.org).

Key stratigraphic horizons (numbered 1-17)

Synorogenic Association (see Fig. 1)

1. Base of Batu Putih Formation belongs to planktonic foraminiferal zone N18 (latest Miocene; 5.51–5.48 Ma according to datum levels of Wade et al. 2011). This marks the beginning of Phase 2 of collision (Haig 2012).

2. Base of siliciclastic turbidite succession in type section of Viqueque Formation belongs within the lower part of zone N21 (within Pliocene; within interval 3.35–3.13 Ma according to overlap of datum levels for base *Globorotalia tosaensis* and top *Dentoglobigerina altispira* following Wade et al. 2011; species distributions given by Haig & McCartain 2007, supplementary Table G). This marks the beginning of Phase 3 of collision. Note that, away from emerging fatus, the Batu Putih Formation ranges through the Pliocene to early Pleistocene.

3. Oldest limestone terrace of Bacau Group belongs within zone N22 (within the interval latest Pliocene to early Pleistocene; within interval 1.93–0.61 Ma; based on overlap of datum levels base *Globorotalia truncatulinoides* and top *Globorotalia tosaensis* following Wade et al. 2011; and species records by D.W. Haig et al. in prep.). This represents the beginning of Phase 4 of collision.

4. The depositional hiatus between the youngest pre-collision unit (see point 5, below) **and the oldest synorogenic unit** is within the interval 8.86 Ma and 5.48 Ma (Late Miocene; based on the datum levels for base *Globigerinoides extremus* and base *Sphaeroidinella dehiscens* following Wade et al. 2011, and using distributions in supplementary tables of Haig & McCartain 2007, and Haig 2012). The hiatus represents Phase 1 of collision.

Timor–Scott Plateau Association (see Figs. 1, 2)

5. The youngest pre-collision unit is within the T-SPA and belongs to planktonic foraminiferal zone N15. The presence of rare *Globigerinoides extremus* in some samples suggests that the highest level is younger than 8.86 Ma; but the persistent occurrence of *Globorotalia limbata* (base at 10.66 Ma) and *Globoturborotalia nepenthes* (base at 11.55 Ma) supports an age no older than about 10 Ma. The absence of recognizable *Globorotalia plesiotumida* suggests that the age is no younger than 8.52 Ma (following datum levels of Wade et al. 2011; and distributions of species recorded in deformed indurated carbonate pelagites by Haig & McCartain 2007).

6. The **oldest carbonate pelagite** dated by planktonic foraminifera of the T-SPA belongs to the late Aptian (Haig & McCartain 2007, supplementary table A; Early Cretaceous; ~ 113–120 Ma).

7. The **oldest stratigraphic unit in T-SPA** is a varicoloured mudstone-sandstone unit containing a *Malayamaorica*–"*Belemnopsis*"-inoceramind molluscan fauna of Late Jurassic age (Kimmeridgian–Tithonian; ~ 145–157 Ma) based on species records of Haig & McCartain (2007) and unpublished records of Mark Collins, José De Sá and D.W. Haig.

Gondwana Breakup in Timor Region

8. The **oldest thin-bedded radiolarian chert/siliceous argillite of deep-ocean facies** belongs to the radiolarian Unitary Association Zone 7 of late Bathonian-early Callovian age (Haig & Bandini 2013; late Middle Jurassic; ~ 165–167 Ma). The unit, placed in the Noni Group (OTA, Fig. 1), represents oceanic strata overthrust during collision onto the Australian continental margin. It places an upper age limit on the breakup of Gondwana and the opening of the Indian Ocean in this region. An age of 165 Ma was also indicated by Metcalfe (2011, fig. 20) for continental breakup in this region.

East Gondwana Interior Rift Association (Fig. 1)

9. The **oldest un-metamorphosed unit** recognized in this association is the Kulau Limestone of Late Gzhelian (latest Carboniferous) age (Davydov *et al.* 2013, 2014; ~ 300 Ma). The unit includes a coral-tubiphyte reef that grew at a time of a global warm climatic spike that is coincidental with the commencement of rapid melting of a vast thick ice sheet that covered much of East Gondwana.

10. The **youngest unit in the EGIRA** is the Wailuli Group. The Wailuli Group ranges from the Rhaetian (Late Triassic; ~ 208 Ma) to probably the early Middle Jurassic (~170 Ma), but the upper part of the Wailuli Group is poorly known in Timor-Leste (McCartain, 2014). A Triassic/Jurassic boundary section has been identified in the Sahem River and is being described and compared to a similar section on the NW Shelf that also shows major turnover of foraminiferal, spore-pollen, and nannofossil biotas at the boundary (R.W. Howe *et al.*, in prep).

11. **EGIRA shallow-water carbonate facies** were present in the Late Gzhelian (latest Carboniferous, around 300 Ma), late Sakmarian–early Artinskian (Cisuralian, Early Permian, around 290 Ma), late Artinskian–early Kungurian (Cisuralian, Early Permian, around 283 Ma), late Wordian–Capitanian (Guadalupian, Middle Permian, around, around 265 Ma), within Wuchiapingian, possibly extending through Changhsingian (Lopingian, around 256 Ma, possibly extending to 252 Ma), Induan through to at least Norian (Early Triassic to Late Triassic, ~252–208 Ma). The Permian limestone units probably represent mounds of varying lateral extent and are conformable with volcanoclastic and siliciclastic strata (Haig *et al.* 2014, 2017). The Triassic deposits are carbonate-platform facies (Haig & McCartain 2012; D.W. Haig, in prep.). There is no evidence for Jurassic shallow-water carbonate units in the EGIRA in Timor Leste (but see OTA, points 15–17).

12. EGIRA "basinal" facies include mudstone-sandstone successions ranging from at least the latest Carboniferous to the Early Jurassic and possibly into the early Middle Jurassic. These units were deposited in varying bathymetric settings. Turbiditic sandstone is common at some levels. Debris slides of shallow-water carbonate sediment into deeper water mud facies are known in the Cribas Group (Permian), Babulu Group (Anisian to lower Norian; Middle to early Late Triassic), and Aitutu Group (Norian, Late Triassic). No such debris slides have been recognized in the Wailuli Group (Rhaetian to Early Jurassic). These observations link the shallow-water carbonate facies (point 11 above) to the basinal facies. Other significant points based on ongoing research are:

- ***Within the Cribas Group:***

- (a) A carbonaceous mudstone with thin sandstone interbeds belonging to the spore- pollen *Pseudoreticulatispora confluens* Zone (probably Asselian, earliest Permian, ~299–293 Ma) outcrops near late Gzhelian carbonate mound-reef deposits in the Hato-Builico region (based on palynology by J. Backhouse).
- (b) Palynological dating of the Atahoc sandstone unit (which contains very thin grey mudstone beds) in the core of the Cribas Anticline has been unsuccessful because of high thermal maturity and carbonization of organic material. The sandstone succession is conformably overlain by fossiliferous red mudstone of probable Sakmarian age (Cisuralian, Early Permian, ~ 290–293 Ma).
- (c) Zircon TIMS analyses by J. Crowley of Boise State University, USA, give an age of 289.00 ± 0.08 Ma (almost co-incident with the Sakmarian–Artinskian boundary; Cisuralian, Early Permian) for an ash bed within a red fossiliferous mudstone succession at Kartolu. Work on the fossil content is still being undertaken, but the assemblage includes the large ammonoid species *Metalegoceras sundaicum* and *Metapronorites timorensis* (identified by T. Leonova, Russian Academy of Sciences, Moscow). This mudstone succession is coeval with the type section of the Maubisse Limestone (Haig *et al.* 2014) that outcrops about 1.3 km to the northwest.
- (d) The type section of the "Cribas Formation" in the Sumasse River is mainly Artinskian–Kungurian in age (Cisuralian, Early Permian, within the interval 290 to 272 Ma). It is, at least in part, coeval with the Bua-bai Limestone (Haig *et al.* 2017).
- (e) Grey mudstone with interbedded sandstone is represented in the Lopingian (Late Permian; characterized by spore-pollen *Dulhuntyispora parvithola* Zone, with palynomorph identifications by J. Backhouse, and correlation following Laurie *et al.* 2016) at localities in the Wai Luli River (McCartain *et al.* 2006), Lasau region (M. Collins, unpublished thesis), and tributaries of the Sumasse River (E. McCartain, unpublished data). The unit may be stratigraphically continuous with the Niof Group of the Early Triassic, but more work is needed to confirm this.
- (f) The Niof Group of Early Triassic age (McCartain 2014), resembles facies present in coeval successions in Western Australian basins (including the

Kockatea, Locker and Blina Shales) and represents a transgressive phase recognized throughout the East Gondwana Interior Rift from Timor in the north to the northern Perth Basin in the South (Haig *et al.* 2015). The same increase in bathymetry is observed in the Early Triassic Lilu deep carbonate-platform facies (Berry *et al.* 1984) that progrades upwards, probably in several cycles, to the shallow carbonate-platform facies of the Bandeira Group (D.W. Haig *et al.* in prep.).

- ***Within the Babulu Group:***

- (a) The type section of the "Foura Sandstone" belongs to the spore-pollen *Staurosaccites quadrifidus* Zone (Middle to early Late Triassic; palynomorph identifications by J. Backhouse) and contains thick-bedded turbiditic sandstone with a major volcanoclastic provenance (based on petrographic analyses of P. Baillie).
- (b) In the Carnian (early Late Triassic) part of the Babulu Group, thin to medium-bedded grey wackestone with radiolaria, similar to those in the Aitutu Group, are present at some localities. These occur as limited interbedded mudstone-wackestone units (usually < 2 m thick) in much thicker mudstone successions. They should not be confused with the Aitutu Group which is characterized by thick successions of thin to medium bedded grey radiolarian-rich wackestone with generally very thin carbonaceous mudstone (often, paper-shale) interbeds. The age of the Aitutu Group is Norian (Late Triassic, ~227–208 Ma).
- (c) The Babulu Group is probably the thickest stratigraphic unit in Timor-Leste and is the most widespread. In many places it is affected by broken-formation deformation where friable mud has deformed in a chaotic ductile manner and the indurated sand interbeds have fractured into blocks that are disoriented in the mud.

- ***Within the Wailuli Group***

Grey thin to thick bedded wackestone interbedded with calcareous mudstone and containing calcispheres is present at some localities in the Sinemurian-Pleinsbachian (Early Jurassic) part of the group. These have a superficial resemblance to the radiolarian-rich wackestone of the Aitutu Group.

Overthrust Terrane Association (Fig. 1)

13. The youngest rocks placed in the pre-collision OTA are deep-sea carbonate pelagites of Early Miocene age (Benincasa *et al.* 2012).

14. Middle Eocene shallow-water limestone with volcanic-derived clasts is present in the type section of the Barique Volcanics (Haig *et al.* under review). Late Eocene and latest Oligocene–earliest Miocene limestone units are also closely associated with mafic volcanics. This Middle Eocene to earliest Miocene assemblage of volcanic and sedimentary strata is designated the Barique Group. A similar coeval lithological association is not present anywhere on the Australian northwest continental margin.

15. Within the latest Oligocene–earliest Miocene Booi Limestone (Haig *et al.* 2008) outcropping on the eastern side of Matabian Range are interbeds of

conglomerates containing limestone clasts derived from the Early Jurassic Perdido Group (characterized by "Bahaman-like" oolitic facies with a distinct algal and foraminiferal assemblage, Haig *et al.* 2007; Benincasa *et al.* 2012; D.W. Haig *et al.* in prep.). These conglomerates should not be confused with crushed-breccia developed along high-angle faults (e.g. crushed breccia described by Haig *et al.*, 2008).

16. At many localities where the Barique Group is present, the Perdido Group forms high fatus (e.g. at Cablac, Mundo Perdido, Laritame, Matabian). The Perdido Group shows more intense deformation and stylolamination than the much younger relatively undeformed limestone slabs preserved in the Barique Group. The difference in deformation and the reworked limestone clasts from the Perdido Group found in conglomerates of the Booi Limestone suggest a major angular unconformity is represented in OTA indicating a complex pre-collision deformation history. The Perdido Group is considered to be Gondwana in origin.

17. The assemblage of units placed in the OTA is found in coherent areas of outcrop in Timor-Leste with the main units (Barique Group, carbonate pelagites, and Perdido Group) usually found associated in each area.

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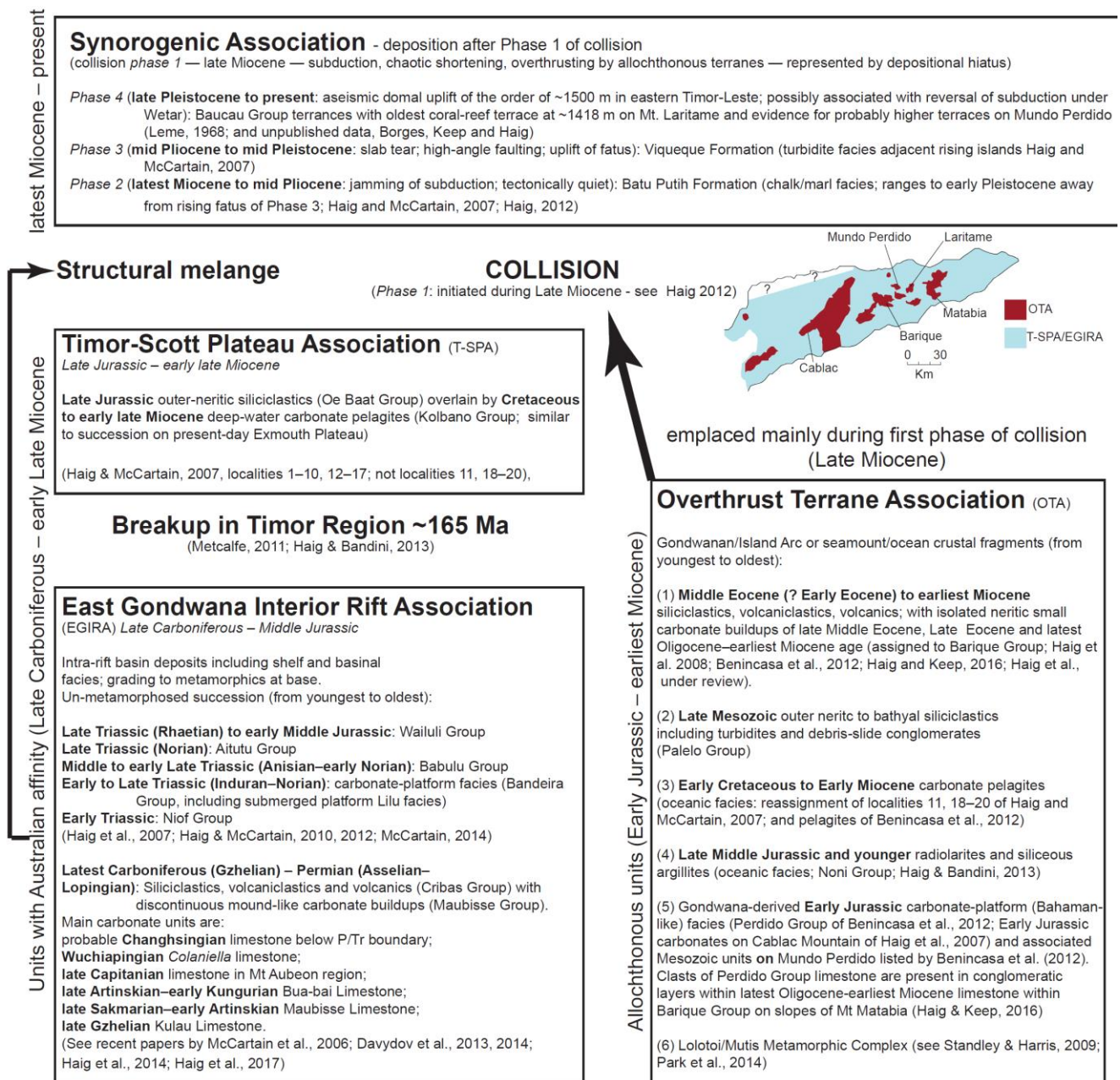


Fig. 1. Tectonostratigraphic interpretation of units observed in Timor-Leste. These are placed in four main rock-unit associations (Synorogenic Association; and the pre-collision Timor-Scott Plateau Association, East Gondwana Interior Rift Association, and Overthrust Terrane Association). Although the internal stratigraphy of the pre-collision associations is chaotic, units within each association outcrop in distinct and coherent areas as indicated on the insert map of Timor-Leste (from Haig et al., under review).

**MATURING ONES UNDERSTANDING ON THE TIMOR LESTE
ONSHORE PETROLEUM AND MINERAL RESOURCES POTENTIALS
THROUGH AN APPLICATION OF THE AN INTEGRATED AIRBORNE
GEOPHYSICAL SURVEYS**

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ABSTRACT

Timor-Leste are blessed with various mineral resources and petroleum which are worth for further exploration and exploitation to be used for the well-being its people. Various academic and industry researches revealed the distributions of occurrences of various mineral resources both metallic mineral resources such as gold, copper, manganese, chromite, etc; and non-metallic minerals resources such marbles, coloured limestone as well as travertine throughout various location within the country. Apart from the existence of mineral resources, further studies on the onshore petroleum prospecting activities in the late 1960s – early 1970s also indicated that there are several potential existence of petroleum sedimentary basins as well as structural high which might conserve the existence of the commercial hydrocarbon existence on the Timor-Leste onshore areas. However, in order mature one understanding on the existence such natural resources, further in depth studies are required. In that, Government of Timor-Leste since the VI Constitution government under the leadership of the Ministry of Planning and Strategic Investment through an inter-ministerial cooperation and coordination with the Ministry of Finance and the Ministry of Petroleum and Mineral Resources initiated an Integrated Airborne Geophysical Surveys (IAGS) utilizing for different airborne geophysical methods such as gravity, magnetic, radiometric, electromagnetic and gravity-gradiometric surveys to map out the distribution of the potential petroleum and mineral resources, as well as to mature our understanding on the existence of such natural resources. This paper is going to discuss about the importance of geophysical data and its application in mapping out the distribution of petroleum and mineral resources within the onshore Timor – Leste area. The paper will focus more on how and why the four different types of geophysical survey methods such as Airborne Gravity, Magnetic, and Radiometric, Electromagnetic as well as Gravity gradiometric survey data were chosen for the case to be used for mapping out the petroleum and mineral resources potential in the onshore territory of Timor-Leste.

PETROLEUM SYSTEM ELEMENTS EVALUATION OF LAGA AND BAGUAI AREAS

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ABSTRACT

Petroleum system element evaluation is a part of hydrocarbon resources studies to evaluate the regional geology and its prospect areas. The study focused in areas of Laga and Baguia, Baucau Municipality, where, previously it's been published in Oil and Gas Seeps Study and Bouger Anomaly Map (IPG's Geophysics, 2017). The methods that used in this study are field study (structural geology and stratigraphy evaluation) and laboratory analysis (Geochemical analysis). The steps of this study are field geology, regional geology evaluation, structural geology evaluation although the laboratory analysis is still in progress. The stratigraphy of study areas divided in to 8 (eight) rock units; Crinoidal Limestone (Permian), volcanic and volcanic clastic, Intercalated Sandstone and Shale, Intercalated Limestone & Shale, Massive Limestone, mélange, marl/chalky limestone and coral limestone (Quaternary). Mainly, Geological Structure of the areas controlled by overturned fold that followed by normal fault that as it seen in Sagadati and Atelary Villages. The result of this study shows, there are 3 (three) types of shales and its association as mentioned. 5 (five) samples of shales were recommended to do the geochemical analysis, 1(one) of them has been done while 4 (four) others are in progress. The analysis of TOC (Total Organic Content) and Pyrolysis of the samples MT-23 LG shows an excellent source rock, and Gas Chromatography Ratio data took place in kerogen type 2 (two). Biomarker from the sample of Shale shows an indication of Olenane (Algae) probably derived from Triassic.

Keywords: Petroleum Elements, Stratigraphy, Structural Geology, MT 23 LG

GEOCHEMISTRY STUDY OF BLACK SHALE IN BAGUIA AND LAGA AREAS

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ABSTRACT

The Geochemistry is study that using chemical principles to determine the composition of hydrocarbons in black shale. The purpose of this study is to indentify the organic content by using Total Organic Content (TOC) and Rock Eval –Pyrolysis methods, the depositional environmental and organic material origin using Gas Chromatography and Gas Chromatography – Mass Spectrometry methods as well as organic petrography analysis to describe the level of kerogen maturity through the Vitrinite reflaktane (Ro) and Thermal alteration Index (TAI). There are five black shales was collected; MT 23, BG 01, LG 20, BG 13, BG 07. The sample of MT 23 is been analysed where four others is still processing.

The result of MT 23 shows that the total organic content is 11.44% (Excellent), and Rock EvalPyrolysis is pyrolysable (S2) 44.60 mg HC /g (Type II). However, the level maturity of Vitrinite Reflaktane (Ro) is 416oC and the ratio of (Ro) 0.30 % which classified as immature. Thermal Alteration Index (TAI) shows the percentage of organic matter; Flourescene Amorphorus 7%, Lipto ditrinite 7 %, categorized as oil prone Type II. The results of Gas Chromatography analysis from MT 23 relatively high pristane/nC17 (2,91) and Phytane/nC18 ratio (3,71) indicated organic facies of algae and origins from marine organic matter. Fragmentogram of triterpanes (m/z 191) biomarker shows predominant abundace of C21 tricyclic (3) and the C23 tricyclic (5) compared to the C19 compounds suggests a possible algae marine origin, another fragmentogram by steranes (m/z 191) show $\alpha\alpha\alpha$ -C29 (15) is dominant compare to C27 and C28 sterane indicating mixed diatom or algae from marine environments.

Keywords: Geochemistry, Rock Eval –Pyrolysis, TOC, Vitrinite Reflaktane (Ro), Gas Chromatography, Gas Chromatography – Mass Spectrometry, Thermal Alteration Index (TAI), Black Shale.

JURASSIC RESERVOIR AND SOURCE POTENTIAL IN TIMOR-LESTE

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ABSTRACT

Jurassic strata exposed in Timor-Leste are poorly understood. In part this reflects the stage of scientific investigation of Timor stratigraphy. However, the limited exposure of Jurassic strata in outcrop also plays a role. Jurassic strata in the Bonaparte Basin, Australia, are better understood and represent both the source for and reservoirs of large hydrocarbon accumulations. These strata are often drawn on as analogues for the prospectivity of the Jurassic succession in Timor-Leste. However, with our current knowledge the Jurassic succession in Timor-Leste does not show the same reservoir and source characteristics. So why is this? How does the Jurassic succession in Banli-1 fit into this picture? And is there any outcrop evidence in Timor-Leste for Jurassic reservoirs or source rocks?

Here we look at what is known about the Jurassic stratigraphic succession exposed in Timor-Leste. This is then leveraged to (1) discuss possible Jurassic paleogeographies that account for Jurassic successions exposed in Timor-Leste, and those penetrated in Banli-1 and the Bonaparte Basin, and (2) discuss the potential for Jurassic source and reservoir presence in Timor-Leste.

**RECONCILING THE MODELED LOG AND CORE BASED
SATURATION HEIGHT FUNCTIONS: A CASE STUDY FROM THE
BAYU UNDAN GAS-CONDENSATE RESERVOIR**

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ABSTRACT

Petrophysicists are adept at calculating water saturation using log data. Likewise they are good at interpreting the core measured capillary pressure data. In reservoir characterization, quite often, petrophysicists are required to transform the log derived water saturation or core based capillary pressure information into saturation height functions for a realistic representation of water saturation in 3D geomodels and simulation models.

If, for example, a field has only log data available the solution is straight-forward, generate saturation height functions using log derived water saturation. The situation gets complicated if the field has both log data and core based capillary pressure measurements.

The dilemma is to decide as to which data to use. As consultants we come across varied data sets in both clastics and carbonate reservoirs all over the world. There are both commonalities and differentiators in these data sets to model water saturation. Solution to each problem could potentially be different. In our experience, very often, there is no unique solution and the saturation height functions can be generated using log data entirely or using core data alone or combining both data sets.

In other words, the outcome is reservoir and data specific as will be shown with an example from a case study from the Bayu Undan gas condensate field at the Bonaparte Basin of Northwest shelf of Australia within Timor Sea. It will be demonstrated in this study that when both data sets are available, reconciling them to arrive at a realistic saturation height model is the key. The intent is to emphasize that there is no universal preference. It is left to the discretion of the petrophysicists as to which path to take in order to generate the saturation height functions as realistically as possible honouring the available data and interpretations.

**CONFERENCE DAY 3 - THE SUSTAINABILITY OF
GEOLOGICAL RESOURCE MANAGEMENT AND
ECONOMICS DEVELOPMENT**

QUATERNARY UPLIFT AND DEFORMATION AS RECORDED BY THE TIMOR-LESTE NORTH COAST BAUCAU LIMESTONE.

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ABSTRACT

The island of Timor is located in an important zone of tectonic transition from subduction to arc-continent collision. In response to neotectonic processes and paleo sea-level fluctuations, extensive sets of marine terraces are exposed along ~180 km of the northern and eastern coasts of Timor-Leste. These terraces are Quaternary in age, as indicated by the coralline material (Baucau Limestone), and provide indispensable markers for identifying neotectonic deformation of the island. The highest and broadest terraces form the Baucau, Lautem, and Los Palos Plateaus, reaching elevations between 500 and 650 meters above average sea-level (asl). Relatively thin veneers of the Baucau Limestone generally overlie late Pliocene synorogenic sediments that were deposited at considerable depth. The Quaternary surface uplift of Timor-Leste has been attributed to aseismic lithospheric processes, namely isostatic rebound. In this study, we map the distribution and patterns of uplifted coral terraces along the north coast and date some of them to quantify surface uplift rates. The scales of surface warping then provide clues to the young geodynamic processes affecting the island, where crustal shortening would have characteristic scale lengths of 10¹-10²km, and lithospheric uplift at scale lengths of 10²-10³ km.

The terraces were mapped using 1:40,000 aerial photos (1957; 1962-63), as well as, other remote sensing imagery, such as the 1987 LANDSAT and ALOS 1 arc second global DEM. Field surveys were also conducted for 10 coastal locations to: (1) measure terrace altitudes with high-resolution GPS, and (2) collect coral samples for U-Th age analyses to determine terrace ages.

The lateral continuity of the marine terraces is disrupted by structures and/or erosion, primarily fluvial and mass wasting; however, some outcrop areas extend

unbroken for up to 20-25 km. Traces of individual terrace inner margins are less continuous, but still allow unbroken tracking of single paleo-horizontal surfaces for a few kilometers. The most reliable correlation can be traced from the Laga to Tutuala regions, where an open and moderately northeast plunging anticline (~ 80 m half-wavelength) warps the uppermost terraces. The northeast tilt of high elevation terraces near Lautem mark the trend and plunge of the fold axis. The backlimb of the fold is identified by the southeast tilting of the Los Palos Plateau and terraces around Ponte Tei (a coastal promontory west of Tutuala). The hinge of the fold would be located between Ililai and Buihomau, as terraces than slightly decline west of Ililai. The decline is not as obvious as the orientation of the coastline to the fold axis is near parallel, thus, we see the forelimb at an oblique view. The Baucau Plateau tilts gently to the NW and the terraces on the western margin tilt slightly to the west. However, whether or not this warping is associated with the same fold as that to the east is uncertain. The presence of a mega landside on the eastern margin of the plateau and the lack of terraces between Baucau and Laga obscure the datum.

The field surveys estimate that late Quaternary surface uplift rates vary between 0.1 and 1.5 meters per 1,000 years (m/ka). The lowest uplift rate was estimated from a beachrock material at 11 m asl that was c. 128.9 ka for a profile 24 km west of Manatuto. The highest rates were estimated from corals approximately 20 m above mean sea-level that yield ages of c. 54-74 ka from the Buihomau region. Using the measured uplift rates alone, the results suggest a background surface uplift rate increasing from 0.1 m/ka near Subau to 0.5-0.6 m/ka near Obrato which then continues ~170 km to the east. This would indicate a broad wavelength of deformation, possibly related to lithospheric scaled processes. However, superimposed on this background uplift rate is a shorter wavelength (< 15 km) of uplift with a mean of 1.2 m/ka around the Ililai and Buihomau townships. Warped terraces and estimated differential uplift rates over sections of both the spatial and temporal terrace record are evidence for short-lived crustal deformational events. Whether or not these small-scaled deformational events are associated with crustal shortening along retro-wedge thrust faults or gravitational collapse is still up for debate. However, this study suggests that there has been young and relatively shallow deformation that have accompanied lithospheric processes.

TECTONIC SETTING OF TIMOR DERIVED FROM SEISMOLOGICAL STUDY (A PRELIMINARY STUDY)

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ABSTRACT

Timor Island is a part of non-volcanic arc that known as Outer Banda Arc. Tectonically, the Island is on collision between Banda Arc and Australian Continental plate, this plate is moving to northeast direction and making very complexity geological deformation. To solve this complexity, some tectonic models had been putting to describe the process of Timor Island deformation, for instance; imbricate, upthrust and thrust models. These models had influenced to the regional structural geology deformation.

The study was focused on the tectonic setting model of Timor which is derived from historical seismicity data from 1980 – 2018. This study data is a composite from various earthquake historical catalog that were taken from IPG, IRIS, USGS, and GEOFON earthquakes catalogs.

The results of study shows that very high seismicity in Timor Region. This is because the Region lies on an active tectonic plate where it is seen that the movement of the Australian Continental plate is moving towards the northeast where this plate subducted to the Banda Arc. However, this region categorized as low to moderate intensity. The earthquake magnitude in this region is no more than 7 with the variable depth. Most of shallow earthquake depth occurred in the southern part of Timor and further to the north more deeper depth.

Keywords: Timor, tectonic, earthquakes, and seismicity.

GEOLOGICAL RESOURCES OF ATAURO ISLAND (PRELIMINARY STUDY)

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ABSTRACT

The geological resources are indispensable for the development of any Nation, as far as the exploitation of the geological resources is economical interesting. The demand for mineral and other resources is increasing, as a new country Timor-Leste needs to do research to figure out the mineral and others geological resources that could be found within this country to be used to support the economy development. The research aims to understand geological setting and to predict the geological resources such as mineral resources, groundwater resources and geothermal resources in the Atauro Island, Timor-Leste. The study consists of three segments namely preparation phase, field work and laboratory work as shown in the framework of the research. The expected results to be achieved are; geological map with scale 1:25.000, mineral anomaly map, groundwater potential map, conceptual model for geothermal system in Atauro Island and from the result of all research, will produce geological resources and potential map of Atauro Island.

Keywords: geological resources, mineral, groundwater, geothermal resources, Atauro Island.

**GEOLOGY AND MINERAL RESOURCES IN CITRANA AREA,
OECUSSE - EAST TIMOR**

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ABSTRACT

Timor Island is located on the non-volcanic Outer Banda Arc. It is the orogenic product of the collision between Australian continental plate with volcanic Inner Banda Arc. The collision resulted in complex tectonics with various rocks derived from Gondwana Megasequence, Australian Margin Megasequence and Banda Terrane (Asian Affinity) are observed throughout Timor. The more recent is the synorogenic deposit. Citrana is an area located in the most-western end of East Timor, part of Nitibe Administrative Post, Special Administrative Region of Oecusse-Ambeno. A semi-detailed geological mapping was conducted in the area with the purpose of mapping the rock formations and identifying their stratigraphical relationship with other rock formations.

Petrographic analysis and remote sensing technique methods are applied in this research. Petrographic analysis supports on determining the mineralogical composition of the rock. Only igneous rocks are subjected to petrographic analysis. Remote sensing technique such as mirror stereoscope interpretation and Landsat-8 image analysis were used to differentiate the geological features in the study area.

The findings of this study show that the geology of Citrana is tectonically chaotic. Rocks that represent Gondwana Megasequence, Banda terrane and Synorogenic Megasequence are all well observed. There are 10 stratigraphic formations identified, which are Evaporite Formation, Maubisse Formation, Aitutu Formation, Babulu Formation, Lolotoe Complex, Diorite Unit, Manamas Formation, Dacite Unit, Suai Formation and Alluvial Deposit. Therefore, tectonostratigraphic comprehension was applied for a better understanding of the origin of the rocks and their stratigraphical or structural relationship.

However, structural measurement was difficult to do due to intensive deformation that caused the rocks to be easily broken and fractured. Sulphide mineralization occurrence also identified and associated with Diorite Unit and Lolotoe Complex. The outcome of this study is to produce a semi-detailed geology map, which highlights the lateral distribution of rock formations and their stratigraphical or structural relationship. Mineral resources are also attached which emphasize a general observation and their uses.

Keywords: Banda Arc, Citrana, Cartography, Petrography

**GEOLOGICAL CHARACTERIZATION OF THE MAQUELAB-
OECUSSE AREA BY INTEGRATING FIELD DATA AND
INTERPRETATION OF PROCESSED LANDSAT 8 IMAGE**

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ABSTRACT

The main objective of the study is to produce the geological map of Maquelab (Oecusse) area with the scale of 1:50,000, by combining field data and the interpretation of processed Landsat 8 image. The produced map might serve as the basis for further work in mineral resources exploration, analysis and identification of geological hazard, hydrogeology study, geotechnical study, etc. The study area is located in the Maquelab village and its surroundings, which covers Suco Taiboco, Lifau, Suni-Ufe and Suco Lalisuc, part of Pante Macassar and Nitibe Administrative Post, enclave of Oecusse, East-Timor. The study involved several work phases such as: (i) the preparation phase with remote sensing interpretation and literature study, (ii) the reconnaissance phase, (iii) the fieldwork phase, (iv) the sample preparation and petrography analysis, and (v) elaboration of the geological map and companion report. Four (4) processing methods are utilized to analyze the Landsat 8 image in ArcGIS program, such as: 1) RGB band combination; 2) Band ratios and indice; 3) Principal component analysis; 4) Supervised classification. Stratigraphically, the study area comprises twelve (12) rock formations and deposits, which are: (a) the Maubisse Formation, (b) the Babulu Formation, (c) the Aitutu Formation, (d) the Oecusse Ultrabasic, (e) the Calc-silicate Unit, (f) the Barique Formation, g) Manamas Formation, (h) the Viqueque Formation, (i) the Bobonaro Complex, (j) the Gabbro Unit, (k) the Suai Formation, (l) the Baucau Formation and (m) the Alluvial deposit. The mineral resources that may occur in the study area are podiform chromite which could be found in the Ultrabasic Complex. Further geochemical studies are needed to better identify the potential of mineral resources.

Keywords: Geological map, Maquelab, Oecusse, Mineral resources, East Timor

MANGANESE EXPLORATION IN TIMOR ISLAND

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ABSTRACT

Timor Island, has a potential manganese ore. The manganese ore in Timor Island represents by mineralization, hydrothermal and underwater sedimentation activities which made the sea water rich of metal materials in very small particle. Tectonically, this island is actively uplifted due to north-trending tectonic collision between Timor Island arc and Australian continental crust. This tectonic activity constructs unique stratigraphy units in the island such as Bobonaro Complex which consists of two principal constituents, scaly clay and exotic blocks of various sizes represents melange olistostrome blocks. The explorations conducted in Timor Island suggest that the host rocks of manganese ore found in this island mainly appeared in Bobonaro Complex. There are three form types of manganese ore discovered in Timor Island; layered, boulder and nodule. The manganese layers are highly deformed, lenticular and segmented. The precision and accurate exploration needs to determined due to the sporadically and unpredictable manganese distribution. The approaches that can be done are series of exploration activities that complete each other. Each step of exploration shall be planned from previous activity, and if those steps are well implemented, then the confidence of information data taken becomes higher and more valuable for production of mine plan. The manganese exploration began with detailed geological mapping; test pit and trenching with manual or heavy equipment then proceed with vertical or incline drilling. The well data record and detailed description are key to proceed to the next steps. The resource and reserve estimation are not discussed in this paper.

Keywords: Manganese exploration, manganese Timor Island, exploration Timor Island

THE STRUCTURAL POSITION OF THE LOLOTOI METAMORPHIC COMPLEX

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ABSTRACT

The tectonic model for the assembly of Timor has been strongly debated for decades. In this talk, I use new field observations of deformed Gondwanan and Banda rocks, along with burial and cooling data, to reappraise the affinity and structural position of the Lolotoi Metamorphic Complex (LMC). Abundant geo and thermochronological evidence ties the LMC to the Mutis Complex; however, the zircon U-Pb data from the southwestern parts of the Lolotoi Complex are ambiguous because published field relations between Triassic sediments and supposedly overthrust Jurassic volcanics of the Fohorem area may be consistent with the volcanics being part of the Gondwana Megasequence. This affinity of the Fohorem volcanics is currently being tested with high temperature thermochronology. In the meantime, recent field mapping between Lolotoi and Mt Taroman has shown that the northern edge of the LMC is a major WNW-striking, north-dipping, dextral normal fault, rather than a thrust fault. This thrusting is overprinted by late folding along the Taroman Fault during dextral-normal slip. The vergence of early folds in the Gondwana Megasequence rocks to both north and south of the LMC suggest that they have been thrust northwards over the LMC, with evidence for at least two phases of north-directed thrusting. However, these Gondwanan rocks display little evidence for tectonic burial and even rocks north of the Basol anticline are unlikely to have ever been overthrust by forearc basement. Gas prone kerogens in Gondwanan rocks of the Bobonaro-Suai area have barely entered the oil window and are less thermally mature than sediments of the Banda cover sequence. A high structural position for the Gondwana Megasequence is consistent with a) records from synorogenic sediments that showed early erosion of Gondwanan rather than Banda rocks b) LMC exhumation in the footwall of faults that have Gondwanan rocks on their hanging wall; and c) similar observations from Savu, an island that appears to be developed on continental forearc basement. Based on existing field mapping and maturation data, I suggest that the LMC in the Suai region is largely buried at depth and being exhumed by transtensional faulting. Current research at The University of Melbourne is focused on documenting the thermal history of the southwestern LMC beyond the range of vitrinite reflectance, to distinguish it from the Australian Passive Margin. I presently interpret the LMC to probably overlie hydrocarbon reservoirs of the Australian passive margin but suggest that the assignment of the Gondwana Megasequence to the lower or upper plate is ambiguous.

ANPM ICT FOR PETROLEUM AND MINERAL DATA

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ABSTRACT

In today business, the organisations need an updated technology to facilitate the work for more effective, efficient and reliable information for the decision making. As modern and example organisation in the region, the ANPM obligates to update its technology system in order to catch the latest technology. By saying so, the ANPM through the ICT department – CS Directorate has to ensure the ANPM ICT is updated and in line with the ANPM needs, and support the ANPM operational in exercising the ANPM roles. In doing so, the ANPM ICT – CS has made a significant improvement within the ANPM ICT system. The ANPM ICT – CS is willing to share the improvements made to the public under through IPG conference.

**UTILIZATION OF DRONE TECHNOLOGY FOR STOCKPILES
VOLUMETRIC CALCULATION: A CASE STUDY FOR RAIKETAN
PRODUCTION SITE**

Jose Joanico Freija de Jesus Soares
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ABSTRACT

The use of construction materials particularly sand and gravel in Timor-Leste has been recorded to be significantly increased in the last two years. Based on the regulatory authority's record, over two million tons of sand and gravel has been quarried and used for infrastructure development in Timor-Leste since 2006, out of which approximately 70% is quarried in 2017 and 2018. The continue increase in demand for construction materials domestically is not only a sign of increasing infrastructure development in the country but also as the source of additional income to the state through payment of fees. Therefore, ensuring an accurate calculation of construction material quarried, processed, and used is important for both quarry operators as well as the government. Moving from past practices of acquiring data to calculate the stockpiles volumes, ANPM is now using drone technology to improve the safety, efficiency, accuracy, and completeness of estimating the stockpiles volumes as well as other regulatory purposes such as carrying out monitoring of quarry activities, environmental monitoring, topographical mapping and field reconnaissance work. The presentation will focus on the processes required to estimate stockpile volume using drone technology and auxiliary software platform for an existing quarry in Raiketan, Municipio Covalima operated by Starking Raw Material Industry, Unip Lda.

**INTEGRATING GEOPHYSICAL AIRBORNE AND GEOLOGICAL
DATA TO CHARACTERIZE KARST AQUIFER AT BAUCAU PLATEAU,
BAUCAU MUNICIPALITY TIMOR-LESTE**

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ABSTRACT

This study envisages the characterization of geology and geophysics data in order to know karst aquifer in the Baucau plateau at Baucau Municipality Timor-Leste. Airborne electromagnetic and airborne magnetic surveys have been conducted by FUGRO on 2nd July 2011. TDEM/SNMR information and boreholes data has been used to enhance the inversion of airborne geophysical data. Coral-reef limestone acts as an aquifer for groundwater and marl and grey claystone of the Viqueque formation act as aquicludes. Baucau formation overlays on a syncline with an axis folding northeast-southwest. The underground drainage pattern is generally controlled by the underlying structure, which has been proved by tracer tests and the groundwater follows the axis of the syncline. Airborne electromagnetic inversion reveals that the thickness of limestone increases to the north (100 m) and decreases to the south-west (5-10 m). Numerous natural spring occur in the gravity sliding zone, due to the aquicludes closer to the surface. Viqueque formation has the largest implication on the groundwater flow in the plateau. Based on borehole and field investigation the lateral distribution ends in Bucoli and Uatabo (road to Laga). This interpretation also supported by airborne magnetic data because the anomaly coincides with the end of the lateral distribution. This implicates that seasonal springs emerge in the north, except in the east of Uatabo beach. In Buraui and Bucoli the emergence of natural spring is related to the aquicludes closer to the surface. Closer to Uailili, Uatabo, and Berecoli the spring occurrences are related to gravity sliding. The discharge measurements and observations in the field indicated higher discharges in the Uailili, Uainoe, Bucoli, Buraui, and Uaihisu, and lower discharge in the Berecoli area. The mean diameter of the conduit from Uailiabere to Uailili spring is estimated to be about 0.5 to 2 m (borehole). Rainfall calculations indicate higher precipitation in the southern plateau (1759.8 mm/yr) and lower in the northern plateau (800 mm/yr). The results indicate that further ground and geophysical investigation is required in five different places: Buarui, Aubaca, Uailili, Fatumaca, and south of Baucau city.

Keywords: karst, underground drainage, airborne geophysical, dye tracing, natural springs

**GEOLOGICAL MAPPING AND GROUNDWATER QUALITY
ANALYSES OF KARST AQUIFER IN BAUCAU MUNICIPALITY**

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ABSTRACT

The research shows that it consists of four lithological units which feature clay complex unit, white shale unit, coral limestone unit and alluvium. The tectonically vergences of the layer inclines to NE. Due to the geological condition, classifies the types of aquifers into three parts: intergranular aquifer, karstic aquifer and localized aquifer. Specifically, to the karstic aquifer was important point of observation, which composed by four springs: Uailili spring, Uaimorimata spring, Uailia spring and Caibada Uaimua spring. According to the laboratory test to water quality by these four springs shows the result of the three parameters: the physicists and chemical properties are normal however the bacteriological parameter is high presence of microbe Coliforms and E.coli, with the existence of microbe in the water composition will affect the quality of groundwater and influence the degree of contamination in drinking water. The type of contamination exists in water is punctual and diffuse contamination.

Keywords: Geology, Hydrogeology, Water quality and Karstic aquifer system of Ground Flow direction.

HYDROTHERMAL ALTERATION AND MINERALIZATION OF AILEU FORMATION

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ABSTRACT

In physiographic regions in East Timor is the meeting of two plates colliding Continental Plates, namely Australia and the Banda Arc, where there has been a removal or uplift. The research areas included in the zone or area of undulating plains to the mountains located north of the southern city of Dili and Ermera. This area has a main constituent rock metamorphic rocks and frozen form. Tectonic Island of Timor has become part of the Banda arc. Timor Island was a zone where the Australian Continental Plate Northwestern part interacts with subduction zones that are no longer active. The subduction zone stretching from North Flores-Wetar, which is part of the Great Indonesian. At first zone of East Timor is a subduction zone, but later evolved into a collision zone. Transition from subduction zone into the collision occurred before the Miocene. Research on alteration mineralization in the northern part of Timor and southwest until now has not been done. The purpose of this study was to determine the spread, the distribution of alteration of rocks, geological structures that control the pattern geometry, the process of mineralization, alteration, and hydrothermal mineralization. These results indicate that the structure formed in the area of research is robust and fault. Muscular structure that occurred in the area Tibar, Dili, Ermera, Timor-Leste caused by magmatism and tectonic activity. Symptoms of fault structures which can be found in the field in the form of fault plane, scratch lines, and concomitant muscular structure. Alteration that occurs in the area Tibar, Fatuahi, and surrounding areas are divided into three types, namely: the type of argillic, propylitic, and silicified (silicic). Mineralization study area abundant in rocks that have undergone alteration in loose material such as schist, phyllite, little igneous rock, gabbro and diorite with coarse sand sized material up lumps. Characteristics of alteration and mineralization at Tibar and Surrounding Area can be grouped into low sulfidation epithermal-type mineralization. From the measurement results obtained mikrotermometri homogenization temperature (current conditions geminating fluid) was 164.2°-201.7° C. Count figures obtained from 28.32 to 116.23 m depth, and a pressure of 4.62 to 11.50 bar. Based on these data, the mineral quartz carrier fluid is formed and grows in the epithermal zone.

**CONFERENCE DAY 4 - ECONOMIC GROWTH AND
VOLATILITY IN GEOLOGICAL RESOURCES AND GEO-
HAZARD**

THE IMPORTANCE OF GEOSPATIAL INFORMATION FOR DEVELOPMENT

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ABSTRACT

The development takes place on the earth's surface, geospatial information is information concerning aspects of the earth's space. Geospatial data and information are needed for planning and implementing the development. Remote sensing technology and GIS software are very important in advancing geospatial information and its use for development. The development of geospatial information in Indonesia intensively since Act No.4, year 2011 about Geospatial Information law was issued.

Keywords: Geospatial Information, GIS, Remote Sensing, Satellite, One Map Policy, Geo-portal, Indonesia.

TSUNAMI MODELLING OF DILI CITY

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ABSTRACT

Timor-Leste is located in Outer Banda Arc. Where, this Island is at the meeting of three large active plates and close to the ring of fire zone. This is due to the movement of three large plates, namely; the Australian plate that moves to the north in the south part of Timor Island, the Pacific plate moves to the west in the east and Eurasian plate moves from the north the south. Earthquake monitoring and catalog of IPG shows that Timor Island is categorized as high seismic activity. Therefore the study come out with some tsunami scenarios related to the big earthquake which are occurred in Tanimbar and Wetar.

The method that used in this study is a Numerical Modelling to estimate arrival time, tsunami wave height and tsunami inundation map based on earthquakes scenarios events at Tanimbar Trough (Tanimbar Megathrust) in 1629 and Wetar Thrust in 1857.

The results analysis shows that; while the Tanimbar Megathrust earthquakes produces a wave height more than 6 meters but the propagation far to Timor-Leste. However, tsunami propagation due to earthquakes on Wetar Thrust in 1857 produced initial wave height up to 6 meters but the lowland in the north of Timor-Leste will be flooded, especially coastal areas with a height wave about 3.5 meters and could reach up to 2.4 km. Estimation of travel time of tsunami wave height at Wetar Thrust will arrive in Dili less than 11 minutes, the northern coastal area of Manatuto is around 18 minutes while the northern coastal area of Bobonaru is about 44 minutes. Tsunamis that occur on Wetar Thrust will cause initial wave height in Baucau = 1.02 meters, Lautem = 0.29 meters, Dili = 0.98 meters Liquça = 0.73 meters and Bobonaro = 0.06 meters.

Keywords: Tsunami, ETA (Estimation time of Arrival), Wetar Thrust, Tanibar Trough, and tsunami wave.

COASTAL GEO-HAZARD STUDY ALONG NORTH COAST OF TIMOR- LESTE

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ABSTRACT

Timor-Leste Island located between the Australian Continent and Banda terrain, the Island has about 783 km length of coastlines (*Global CAD and ITB-CCC*, 2017). Approximately, 66% of the population lives in coastal and lowland area below an elevation of 500m (*USAID*, 2015). The Island composes of 13 Municipalities; where there are 10 Municipalities related to the coastal areas. The natural hazard/ Geologic Hazard phenomena occurrences in Timor Island, including; Landslides and Flooding, have destroyed several basic infrastructures to the population in the country. The Geological activities such as Earthquakes, and landslides, which can cause tsunamis and change the sea, level (The Australian Greenhouse Office, 2005). The main objectives of this study is to validate the ground condition of coastal areas in North Part of Timor-Leste, and Generating the coastal instability map of areas affected by coastal flooding, using field data collection combined with the LIDAR Analysis, as well as Recommending the adaptation strategies and mitigation on minimizing/reducing the coastal hazard occurrences in the hazard prone areas. There are several parameters used in this study, including the factors/causes affecting the coastal hazard, its Geological and Geomorphologic Condition, the imagery analysis using the LIDAR, as well as the field observation, in understanding the typology of the North coast areas of Timor-Leste. This study also generated the Coastal Instability Map, in terms of physical characteristics and the socio-economic analysis. There are adaptation measures in reducing/minimizing the occurrences of coastal flooding/inundation, abrasion and erosion, which recommended by the IPCC AR4: to base the adaptation measures on the concept of Coastal Zone Management Strategy (IPCC CZMS), Such as: To Protect the coastal areas, to accommodate hazard, and to retreat from the coastline when the area is prone to the hazard occurrences.

**INITIAL STUDY OF SHALLOW GROUNDWATER QUALITY BY
USING SOME PHYSICO-CHEMICAL AND MICROBIOLOGICAL
PARAMETERS IN DEBOS AND SURROUNDING AREAS-SUAI
MUNICIPALITY**

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ABSTRACT

This study aims to know the affecting factor on shallow groundwater quality in Debos and Surrounding Areas. There was 41 observation points and 17 of representative water samples that have been taken from dug wells and boreholes were analysed on the month of February 2016 by Direção Nacional dos Serviços de Água, Timor-Leste. The water table depth of the area is range from 0.4 m to 19.6 m below surface. The Ainaro gravels and Alluvial deposits are considered as aquifer in study area. We interpreted the Viqueque formation is located beneath those deposits and has petroleum content.

The result shows current groundwater contamination sources of pH, Coliform and E. Coli may be the consequence of domestic waste which is carried out years ago and the high value of Electrical conductivity and Sulfate in Suai Loro area was caused by the salt water intrusion (natural effect). Moreover, the petroleum contamination on the groundwater in well BH1 and Sp 1 was interpreted as result of the aquifers leakage due to the drilling activity. Overall, the shallow groundwater in study is safe to drink except some wells in Matai, Suai Loro and Tabacolot (Debos) that has exceeded the limit of WHO standard for drinking water and we suggested to evaluate the aquifer distribution for groundwater sustainability. Furthermore, the relevant stakeholder needs to socialize the minimum distance between cattle pen and septic tanks from wells to local community in the region to anticipate the severe pollution in the shallow aquifer.

Keywords: Physico-chemical and microbiological parameters, water quality, shallow aquifer.

IDENTIFICATION OF GEOTOURISM POTENTIAL: TOURISTIC ZONE OF ORIENTAL, CENTRAL AND OCCIDENTAL

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ABSTRACT

Identification of geotourism potential in Timor-Leste is a preliminary study with the main objective of collecting and providing data to develop geotourism objects into geotourism sites in the future with the principles of environmental conservation, natural science and geotourism attraction through socialization and building public awareness to participate in the protection of geotourism objects that have been identified. Through the potential of identifying geotourism objects, it is hoped that it can attract the attention of tourists to visit the geotourism area and will increase the country's income economically, especially the local community. Accordingly, identification of geotourism potential in Timor-Leste as an initial step in the development of the natural tourism sector.

This research study is based on two (2) stages i.e. literature studies and field work. Literature study is an accumulation stages of reference needed from various sources, especially about geotourism and geology of Timor-Leste then interpreting, organizing, identifying study concepts and fieldwork research methods. Geotourism potential objects that have been identified are directly collected from field observations through qualitative methods such as "GIS Survey and Descriptive" and quantitative methods like "Questionnaire" to the community. Lastly, the database is used and analyzed through computer software such as ArcGIS, Global Mapper, CorelDraw, EasyGPS and Map Source afterwards resulting geotourism maps, reports and presentations. Geotourism potential objects that have been identified in Timor-Leste be found 108 geotourism objects from a total of 6 Municipality i.e. Lautem Municipality has 18 geotourism objects, Baucau Municipality has 22 geotourism objects, Dili Municipality has 19 geotourism objects, Ainaro Municipality has 16 geotourism objects, Ermera Municipality has 18 geotourism objects and Bobonaro Municipality has 15 geotourism objects. Furthermore, from all identified geotourism potential objects will be withdrawn and classified into geotourism areas based on existing geodiversity. Hence, there are 8 geotourism areas identified i.e. Geotourism in Nino Konis Santana National Park, Geotourism of Legumau Mountain, Geotourism of Matebian Mountain, Geotourism of Plateau Baucau, Geotourism of Ossuala and Ariana Mountain, Geotourism of Tatamailau Mountain and Mount Ramelau, Geotourism of Leolaco Mountain and Geotourism of Atauro Island. Based on the identification of geotourism objects in Timor-

Leste, it was concluded that the general potential of geodiversity in Timor-Leste is very prospect to develop each geotourism object into a future geotourism site area.

Keywords: Identification of Geotourism Potential, Geodiversity of Timor-Leste.

DEVELOPMENT AND APPLICATION OF DATABASE SYSTEM OF GEOLOGICAL AND GEOTECHNICAL INFORMATION

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ABSTRACT

The knowledge of geological formations and geotechnical properties such as the strength of the ground is necessary to develop infrastructure. For this reason, the subsurface investigations at construction areas are necessary especially for the important structures such as bridges, ports, buildings, highway, landslide prevention works and so on. The subsurface investigation herein means geotechnical exploration, for example, boring survey, standard penetration tests, sounding, soil samplings, and soil tests. These results of the investigation, built into a database, are very useful for the maintenance of the structures and later construction of other structures at nearby areas. The databases make it possible to manage the data efficiently, which are otherwise scattered and kept idle. The databases also make it possible to use effectively the accumulated geotechnical data. Furthermore, digital databases may eliminate long time storage of a stack of thick reports on soil exploration and soil tests.

The paper introduces a typical example of the development of the database systems for geological and geotechnical information, as well as the examples of application for the databases in Japan. Although the databases are useful, there are some issues related to the database systems. Major issues are (1) reliability of data, (2) skill and ability of technicians who perform site investigations and soil tests, (3) format of input data, (4) copyright of data and (5) utilization of database. The paper also discusses these issues.

Keywords: Geotechnical information, Database, Soil exploration, Boring log, Soil property

CONCEPT AND DESIGN OF IPG SDI's

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ABSTRACT

An Integrated system of IT Technology for managing Spatial Data and Information is one of the important pillar for National Development monitoring. Timor-Leste is continues to change in terms of Infrastructure development and also in Geological conditions. With this in mind, Spatial Data Management will take an important role to support scientist and Government for better understanding of Timor-Leste Terrain Characteristics before implement National spatial Planning in Territory. IPG SDI's Concept is the right answer to manage, communicate, generate and sharing all spatial data in integrated system with modern IT Technology. The aim of this presentation is to present the IPG's Concept of Spatial Data Infrastructure, including 5 important aspects of SDI, IPG's Geodatabase and data publication through IPG web-GIS. Moreover, the presentation will highlight application of Spatial Data in: "Systematic, Centralized and well Organized" and also the benefit of IPG GeoDatabase – DATA CENTER for National Development.

**THE IMPORTANCE OF ENVIRONMENTAL DATA MANAGEMENT
AND DISSEMINATION AS A FORCE FOR MEASURED, RATIONAL
AND SUSTAINABLE ECONOMIC DEVELOPMENT IN TIMOR-LESTE**

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ABSTRACT

Timor-Leste is a relatively new, developing country. Its land area is small, whilst its population is growing. Since independence, the economy has been largely supported by the petroleum sector and that is likely to continue, at least in the short term. However, there is an acute awareness of the need to develop a diversity of industries for the country's long-term economic stability, once non-renewable resources are exhausted. The key environmental issues in Timor-Leste are consistent with other developing countries, including deforestation, land degradation, water scarcity, poor water quality, waste management and loss of biodiversity. Timor-Leste will depend on good management of its precious natural resources, and on sound environmental practice to deliver beneficial social outcomes in the future.

All project proposals are subject to an Environmental Impact Assessment and licensing process, which is underpinned by Decree Law. As well as conducting scientific studies on environmental conditions on the ground, this process also includes extensive consultations with local people in affected communities, from which we learn a great deal about the resources upon which they depend: such as water supply, flora, fauna and places of heritage importance.

Sharing of natural resources data and information promotes integrated decision making and good land and water governance. Data and information are also key ingredients for sustainable development.

However, Timor-Leste has very limited baseline information, which is a key component in the environmental impact assessment. The better the available baseline information is, the better we can understand the potential impacts of a development and identify the most appropriate mitigation measures we can put in place.

Without an adequate pre-disturbance baseline, the magnitude of any post-development change cannot be effectively predicted or its impacts assessed. Comprehensive regional baseline datasets are essential to underpin the assessment of the possible impacts of any new industry and to inform the site-specific quantitative impact risk assessments - for example, water quality, public health, biodiversity - that are being conducted.

There is significant room for improvement in data and information management in Timor-Leste: there are many gaps. Accessing and disseminating data is a challenge.

Enhancing awareness of the value of information and the importance of sharing it, as well as securing sustainable funding for establishing, improving and monitoring networks is essential. More human and financial resources should be allocated to meet development objectives. Training on best data and information management systems and practices can help improve data availability and reduce data loss. Timor-Leste should take advantage of the rapid development and growth of new techniques, strategies and tools of data capture and management which offer great opportunities for filling the gaps in baseline, assessment and monitoring.

Natural resources are the cornerstone of local and national development in Timor-Leste, since these will be exploited to support the economy. During the long period of colonisation and occupation, there was significant destruction of the natural environment, leading to deforestation, unstable landscapes and a dramatic decrease in biodiversity and importantly a decrease in available food, fuel and building materials for the community. Timor-Leste has a very ambitious development plan and we are going to see a dramatic change in the landscape over the coming years, with new infrastructure supporting a growing petroleum industry, agriculture, tourism and an emerging mining industry. Working together, we need to use world's best practice, good science, sound engineering, robust technical and quality reviews, and transparent and clear communication to all stakeholders to ensure we don't make the same mistakes that other countries have made in the past.

SLOPE STABILITY AND ROCKFALL HAZARD ANALYSIS ALONG KARIMBALA ROAD, LIQUIÇA MUNICIPALITY, TIMOR-LESTE

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ABSTRACT

Timor-Leste has a rough topography and a complex geology contributing to the occurrence of many slope stability problems, which are aggravated by recent road construction activities aiming to improve the old roads. Many cuts, sometimes with a considerable height are a frequent cause of several failures that require a detailed study. The study area where the research on Slope Stability Analysis (SSA) was done, is in Maubara, in the Municipality of Liquiça, along the Karimbala road, which links the Liquiça and the Bobonaro Municipalities. It was verified that slope failures have occurred systematically throughout the years, the most recent ones occurred in January 2018. The general objectives of this research were to study the slope stability problems and to compute the Factor of Safety (FoS). For the characterization of the slope material and its geomechanical classification, the slope was mapped to define the outcropping materials, the discontinuities were characterized, and the strength of the rock was evaluated using the Schmidt hammer. Based on the data collected in the field, the RMR and the SMR geotechnical classifications were applied to the slope. The evaluation of the stability conditions was also done using the Rocscience software (SLIDE, ROCKFALL and ROCTOPPLE) suitable for each individual slope failure. The Rockfall Hazard Rating System (RHRS) classification guidelines to rate each occurrence was also used. The types of failures identified were rockfall, toppling, debris fall, plane failure and wedge failure. Rockfalls and debris fall are frequent on all slopes from Slope 1 to Slope 5, in contrast to the wedge failure, which only occurs in Slope 2 and Slope 6. The main causes of slope instability are the geological discontinuities with unfavourable orientation, the surface weathering and the intense rainfall which add weight and induce high water pressure in the slopes. The FoS values computed lower than 1.5, are considered as insufficient for a long-term stability. The RHRS results computed are greater than 300. Therefore, it can be concluded that Slope 1 to Slope 5 are vulnerable to additional slope failures. Mitigation must be urgently implemented to reduce damages in the road and drivers. It is highly recommended to develop proper technical design of the slopes considering a FoS suitable for long-term stability, using improvement techniques adjusted to the local conditions such as: reduction of slope height (reduction of overburden stress), reduction of slope angle (reduction of overburden stress), drainage improvement (reduction of pore water pressure), reinforcement of slope (increase of shearing resistance of slip surface). In a few

slopes presenting unstable conditions a few improvement stability procedures were simulated, to evaluate the best procedure to be used.

Keywords: Slope stability analysis (SSA), Factor of Safety (FoS), rockscience software, geotechnical classifications, mitigation

MICROTREMOR HVSR STUDY OF DILI CITY TIMOR-LESTE

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ABSTRACT

It is a well-established fact that the degree of damage due to an earthquake depends on the dynamic properties of soil and on the amplification of seismic waves. Also geologic deposits can amplify strong ground motions depending on the physical conditions. Amplification can be identified by using written records in different thickness of soils for one or several earthquakes, but the major restraint is the resource limitation i.e., availability of these records is impossible at all times. This limitation can be overcome by recording the microvibrations of the ground. Dili is one of the important urban centre and a major business centre in the state of the Timor-Leste. It is located on the banks of the Comoro River which occupies an area of about 48.268 km² and is located 8° 34'S 125 ° 34E. To estimate the peak frequency of ground and to study on the loose alluvial strata, extensive microtremor testing has been carried out in Dili at 18 locations to understand the site specific ground response during earthquake shaking. Microtremor technique is one of the recent advances in the geophysical survey techniques but is quite different from the other methods. Analysis has been done at all test sites using microtremor records and predominant frequency map is generated which reflects the fundamental characteristics of possible side effects.

Keywords: Soil Amplification, Historical Microtremor, Natural frequency, Nakamura method