Exploring Timor-Leste: - Minerals Potential

Francisco da Costa Monteiro[1], Vicenti da Costa Pinto[2]

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[1] Natural Resources Counterpart, Office of President, Palacio das Cinzas, Rua Caicoli Dili, Timor-Leste, +670 7249085, frans_dacosta@yahoo.com

[2] Director of Energy and Minerals, Ministry of Development and Environment, Fomento Building, Timor-Leste, + 670 7236320, dacosta68ili@yahoo.com

Abstract

The natural and mineral resources, with which Timor-Leste is endowed are waiting to be developed in an environmentally friendly manner for the greater economic and social good of the people of the this newly independent nation. The major metallic minerals in Timor-Leste are gold, copper, silver, manganese, although further investigations are needed to determine the size, their vertical and lateral distribution. Gold is found as alluvial deposit probably derived from quartz veins in the crystalline schist of (Aileu Formation). It can also be found as ephithermal mineralisation such as in Atauro island. Nearby islands, Wetar, Flores, and Sumba islands of Indonesia Republic have produced gold deposit in a highly economic quantity. In Timor-Leste, the known occurrences of these precious minerals are mostly concentrate along the northern coastal area and middle part of the country associated with the thrust sheets. The copper-gold-silver occurrences associated with ophiolite suites resembling Cyprus type volcanogenic deposits have been reported from Ossu (Viqueque district), Ossuala (Baucau district), Manatuto and Lautem districts. The Cyprus type volcanogenic massive sulphides are usually between 500.000 to a few million tons in size or larger (UN ESCAP-report, 2003). Therefore it is worth of exploring such potential. The Government policy on the natural and mineral resources is clear; that is: to explore and develop with sound mining practice for the benefit of people of Timor-Leste with special attention to the environment protection, and in a sustainable manner. In line with this spirit, the draft mining legislation, which is now in the government circulation for approval, has, indeed, emphasised the importance of environmental protection and sustainable mining operation through the establishment of structures to support them, in one hand. And in the other hand, the formation of infrastructure, institution and human resources capacity building to create and promote a good business environment that encourages private investment.

1. GENERAL BACKGROUND

Location

Timor lies some 750 km to the north of Darwin, and is separated from the Australian continent by a 3 km deep trough. It is situated in the southeast part of Indonesia archipelago and is one of the islands of the southern Outer Banda Arc, **Figure 1**. Politically, the island is divided into West and East Timor, with the former belongs to Indonesian republic. The newly independent Timor-Leste comprises the eastern half together with the enclave Oecussi in the West, Atauro island in the north of Dili, and a small islet, Jaco, at the eastern most tip of Timor. Administratively, Timor-Leste is divided into 13 districts with each district headed by an administrator. Dili is the capital of the country. The climate is tropical, with topography of the island is dominated by rugged steep sided mountainous terrain to the north and relatively subdues morphology to the south. Important minerals occurrences are in the middle and north part of the country.

Geology

Timor-Leste takes half of the Timor Island, which is regarded as part of Outer Banda Arc islands. This arc is non-volcanic arc, except Atauro island the Miocene-Pliocene volcanic island. Timor, based on published tectonic models, is believed to be formed by a complex of stack thrust sheets accreted over the Australian continental margin deposits during Middle-Miocene (Audley-Charles, 1968) and Middle-Pliocene (Carter et al., 1976). Although, due to the complex distribution of rock units as a result of tectonic disturbances, four distinctive tectonostratigraphic units can be recognised in Timor-Leste, **Figure 2 & 3**. They are:

1. The autochthonous units which encompass all the rock units that were deposited in Timor basin (insitu) during and after major orogenesis. These include the Late Miocene-Pliocene mollase deposits (Viqueque Formation), and Quaternary reefal carbonates and alluvial deposits (Baucau, Poros, Suai and Ainaro Formation).
2. The parautochthonous units that are the relatively coherent pre-collisional Australian continental margin deposits which were brought to its present position by the northward drifting of Australian continental plate. This forms athe largest component of the Timor island and indeed Timor-Leste (e.g., Audley-Charles, Charlton et al., 1991). They consist of Permian turbidite sandstones and limestones, and interbedded with basalt (Atahoc and Cribas Formations), Triassic pelagic limestones (Aituto Formation) and sandstones (Babulu Formation), Jurassic shales (Wailuli Formation), Cretaceous radiolarite and shales (Waibua Formation), and Early Tertiary shelf limestone (Dartolu, Borolalo, and Cablaci Formations), and the pre-Permian metamorphic complex (Lolotoi Formation)
3. The allochthons units which are comprised of Permian to Jurassic metamorphic rocks (Aileu, Maubisse Formations), and possibly some Tertiary Banda Arc

Terrains (the Oecussi and Atatapupu volanics, which were detached from the lower crust and overthrusted onto parautochthonous and autochthonous units.

4. And the olistrostrom units that comprise of variety of unsorted angular to subangular block of Permian to Early Miocene (occasionally to Late Miocene) in a scaly clay matrix (Audley-Charles, 1968; Charlton et al., 1991). This unit is known as Bobonaro Scaly Clay Formation.

Tectonics

The tectonic history of the island has been subject to debate for decades, not a single structural explanation has yet been sufficient to explain all the complexities it has. However, it is widely accepted that Timor was formed as result of collision between Australian continental plate and Banda Arc (Asian microplate). The timing of these collision has been so far interpreted as from Middle Miocene to Mid-Pliocene (Audley-Charles, 1968; Carter et al., 1976) bringing about the thrust sheets that are now can still be seeing as Klippen in most hill tops in the island. This collision was followed by rapid uplift in the Late Pliocene and Quaternary that has removed most of the thrust slices open the structural windows to the pre and syn-collisional sediments. The windows provide access to possible metals and hydrocarbons of Mesozoic sedimentary sequence. The mafic and ultramafic thrust slices are the focus for most of the metallic minerals and massive volcanogenic sulfide deposits (ESCAP-report, 2003). The occurrence of mineral potential can be regarded as closely associated with these tectonic activities and their distribution is controlled by the geological structure domain, which is east-westly directional.

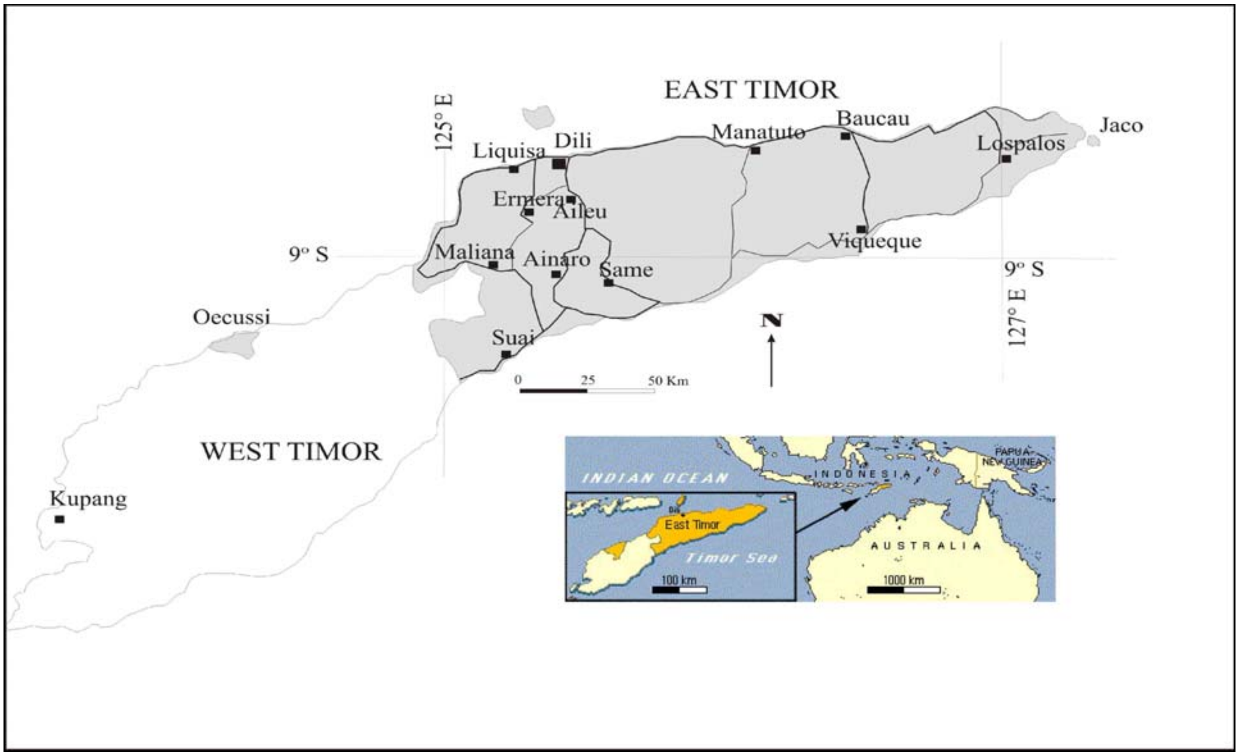

Figure 1. Location of Timor-Leste (East Timor) and surrounding areas.

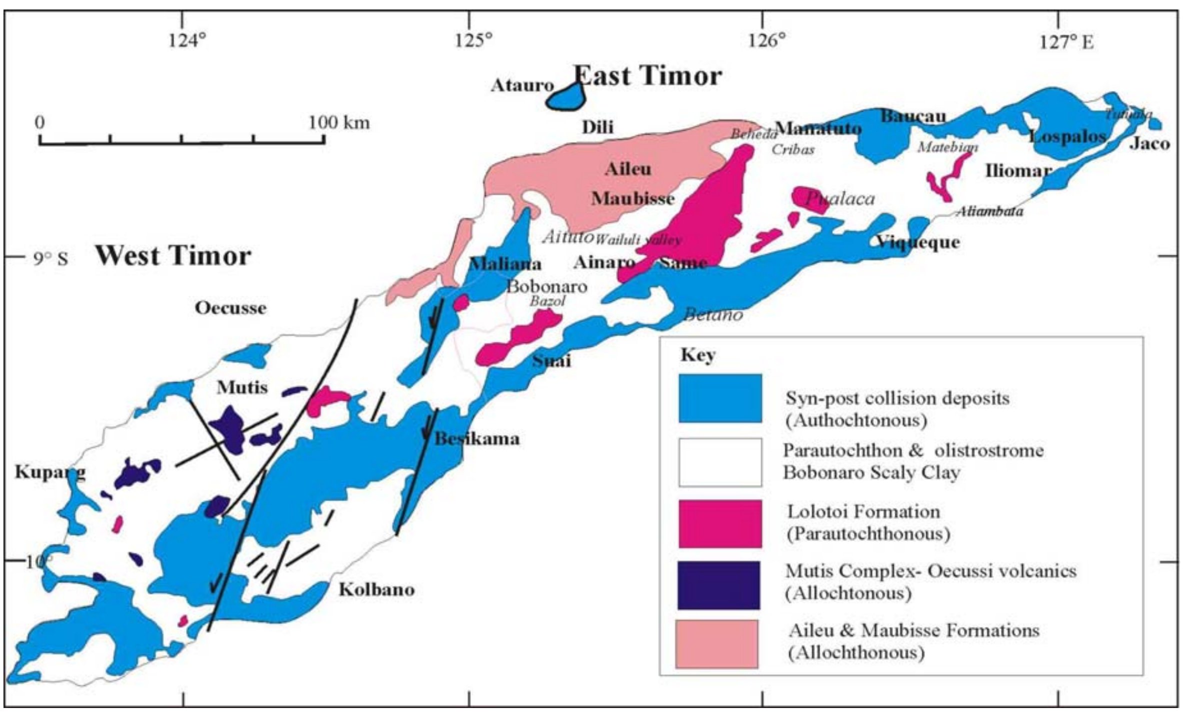

Figure 2. Generalised geological map of Timor with modification (Charlton, 2002)

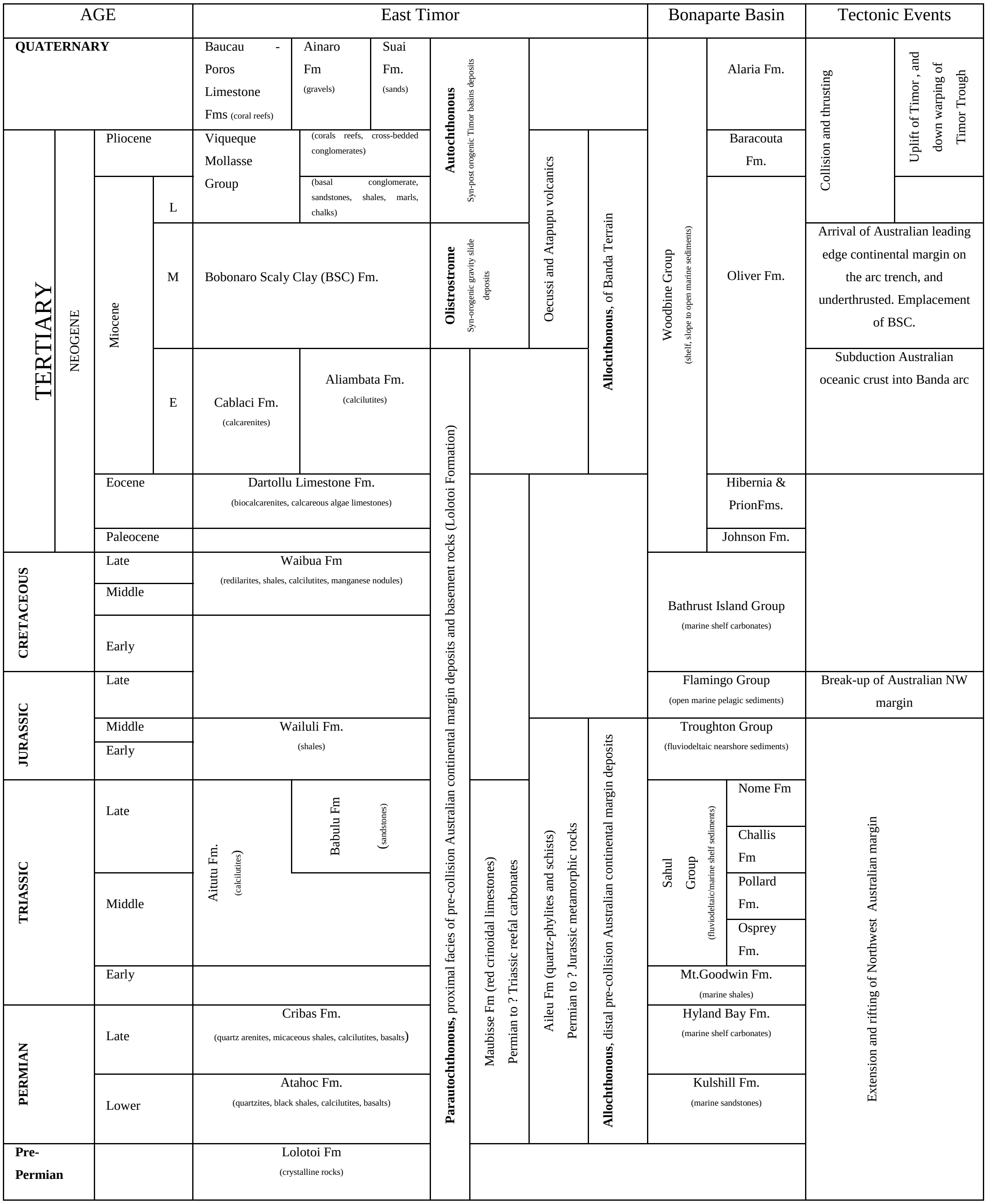

Figure 3. The generalised stratigraphy of Timor and the Bonaparte Basin. Nomenclatures are ased on various sources (e.g., Audley-Charles, 1968; Charlton, 2002; Monteiro, 2003).

2. MINERALS POTENTIAL

Metallic Minerals

The complex geology of Timor Leste is favorable for the occurrence of a wide variety of minerals as well as hydrocarbons. More than 200 minerals occurrences are known to be distributed throughout the country. Some important metallic minerals known to occur in Timor-Leste are such as gold, copper, manganese, silver, chromite. The occurences of these precious metal can be linked to the complex geological feature that Timor-Leste does have. As mentioned earlier in the tectonic history, the island of Timor was built by the collision that resulted in the development of an inner arc volcanic terrane, the Atauro island. This island has been known to be good potential for gold and other precious metal deposits (UN ESCAPE-report 2003), **Figure 4**. Whereas, in the Timor island a series of thrust sheets were emplaced. These thrust sheets consist of ultramafic, mafic, and volcanic terrain that were part of Banda Arc, and have been called as Banda Terrane (Harris, 1991). The main metallic minerals potential in Timor-Leste is in the ultramafic rocks, **Figure 5**.

Non-Metallic Minerals

Non metallic minerals of the primary importance are sand and gravels, limestone for cement, clay for bricks. Others such as bentonites, kaolinite, marbles, gypsum, and phosphate are also of great potential for development, **Figure 6**.

Mineral Occurrences in Timor-Leste

Mineral occurrences in Timor-Leste have been reported from time to time, since Portuguese colonialisation to Indonesia occupation in several official publications. One extensive minerals database was prepared by Mr. Vicente de Lacerda in 1999 for the Office of Mineral and Energy Department of Indonesia, but in this paper the author follow the result of latest report published by UN ESCAPE for the Government of Timor-Leste.

The orogenic history of Timor plays a critical role in defining the location of its metallic mineral occurrence, notably copper, gold, silver, chromite, manganese, and a number of important non-metallic minerals such as limestone, marble, bentonite, gypsum and phosphate. The northern edge of Timor island is host to a number of important mineral occurrences. One of the potentially richest copper zones is the north edge of Ambeno (Oecussi Enclave District). The base metals and their associated precious metals are concentrated in ultramafic rocks, which are part of allochthonous ophiolite suites. Precious metals such as gold and silver were also deposited in and adjacent to volcanic centers as a result of epithermal activity. Some important copper occurrences are also located in southern Baucau and Viqueque districts. Less significant deposits of chromite, manganese and iron sand deposits occur in Manatuto, Baucau and Lautem districts and on Atauro island of Dili districts. Rare occurrence of lead and zinc are known.

The widespread occurrences of limestone and marl, specially in the eastern and western coastal areas of Timor-Leste are important and are amongst the few minerals that have been exploited for many years. There is potential for development of ornamental stones from numerous good quality marble occurrences in Manatuto district east of Dili. Argillic alteration has resulted in the development of a red to white clay complex in the Aileu Formation. It extends from Dili district to Aileu and Ermera districts. River valleys throughout the country include a wide range of sand and gravel deposits.

A brief summary of mineral indication and occurrences based on the UN ESCAPE-report are as follows:

<u>Copper</u>

The mineralisation occurs as sulphides veinlets containing chalcopyrite and pyrite in the ultra basic units, with extensive serpentinites alteration and with evidence of intrusive diorite/diabase. In Ossuala area (Baucau district) sampling by Allied Mining Company (Wittouck, 1937 in Bambang, 2003) indicates grade values of 10% Cu, 3 g/t Au and 170 g/t Ag.

<u>Gold</u>

The gold mineralisation has been observed in several forms as quartz, quartz-calcite and calcite veins hosted by shale/slate or schist. The veins are commonly pyritised and mineralised with gold. In Hilimanu area the mineralisation occurs in the metamorphosed igneous rock. The mineralisation are associated with quartz vein (0,5 – 12 m wide) containing chalcopyrite, limonite and calcedony. Some samples indicate an average grade of 0,5 g/t Au and 50 g/t Ag.

Chromite

The chromite deposits has been reported from Baucau, Hilimanu (Manatuto district) and Manufahi districts. The deposits were found as primary mineralisation in the serpentinites hosts. There has two mineralisation type i.e; Schlieren and Podiform chromite. The podiform chromite in the Manatuto districts is similar to chromite mineralisation in allochthon ophiolite bodies found in the Circum Pacific belt in the Philippines, New Caledonia and Kalimantan, Indonesia. The quality of the chromite is good, with grades between 36% and 51% Cr_2O_3. As for grade, 80% of the world's major deposits have between 33% and 52% Cr_2O_3.

Manganese

The manganese deposits were discovered in several places such as Vemasse, Talamata, Venilale (Baucau district), Uato-Carbau (Viqueque district). The deposits are interbedded form within red shale and associated with the limestone of the Bobonaro Formation. The manganese deposits mainly composed of pyrolusite mineral with the grade range between 84 – 94.5% MnO2.

Phosphate

The deposits are located in Daemena, Abo (Quelicae-Baucau district), and Laleia (Manatuto district). The phosphate deposits occurs in the unconsolidated gravel - boulder material which similar age to the Ainaro Gravel. Analysis result of the samples taken from Abo area has revealed the significant assay ranging from 9.97 % to 21.55% P2O5. The best assay was recorded from Japan Development Consultant showing 31% P2O5.

Bentonite

Bentonite-clay deposit is partly bedded of the claystone of Bobonaro Formation and located at Venilale (Baucau district), Bobonaro (Bobonaro district). In Mulia-Quelicai village (Baucau district), the swelling value was recorded between 371 up to 1829 x dry volume. Mineral reserve has been estimated to be approximately of 115,570,000 cubic metres (around 6 X 6 km^2).

Marble

The deposits have been recorded at Cablaci-Same (Manufahi district), Laclo (Manatuto district) and Builale (Viqueque district). In Laclo, the gross mineral reserved is thought to be at least 5.000.000 cubic metres.

Gypsum

The gypsum deposit was found to be associated with claystone of the Bobonaro Formation. The deposit is located at Laleia-Obrato (Manatuto district), result from the test pitting investigated area of 50 has revealed the mineral reserved to be approximately of 400 tonnes.

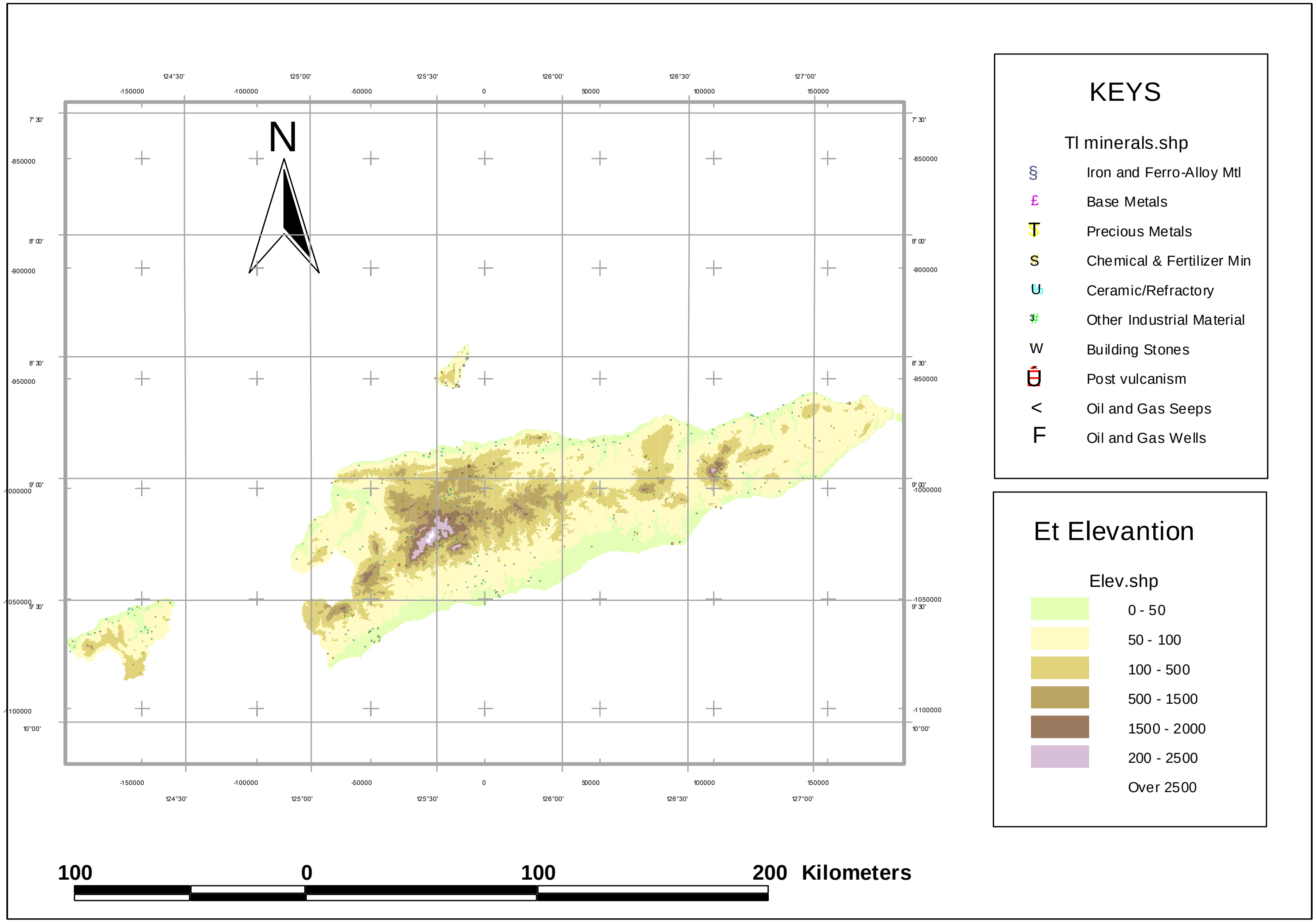

Figure 4. Compiled map of mineral occurrences in Timor-Leste.

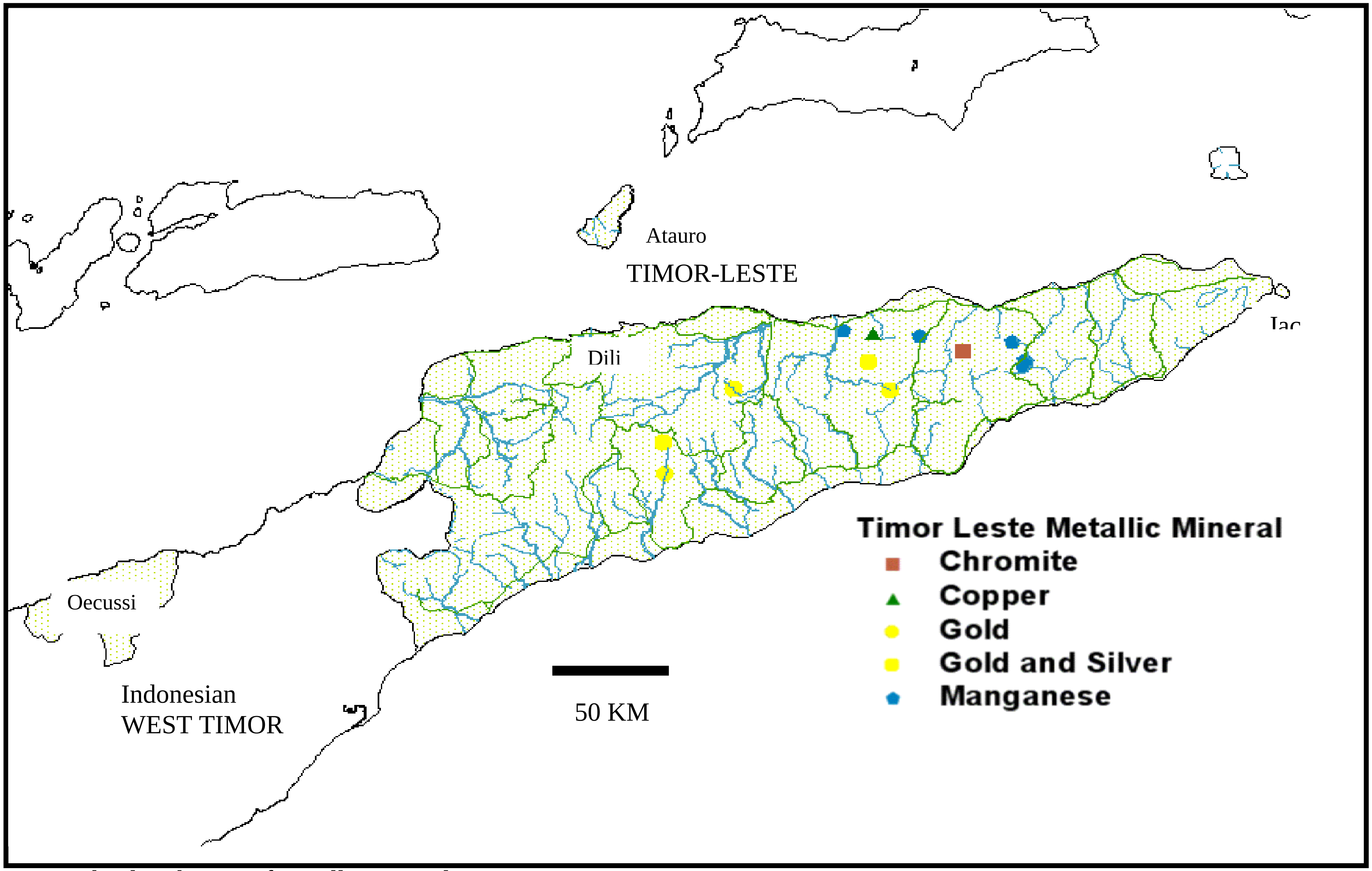

Figure 5. The distribution of metallic minerals in Timor Leste

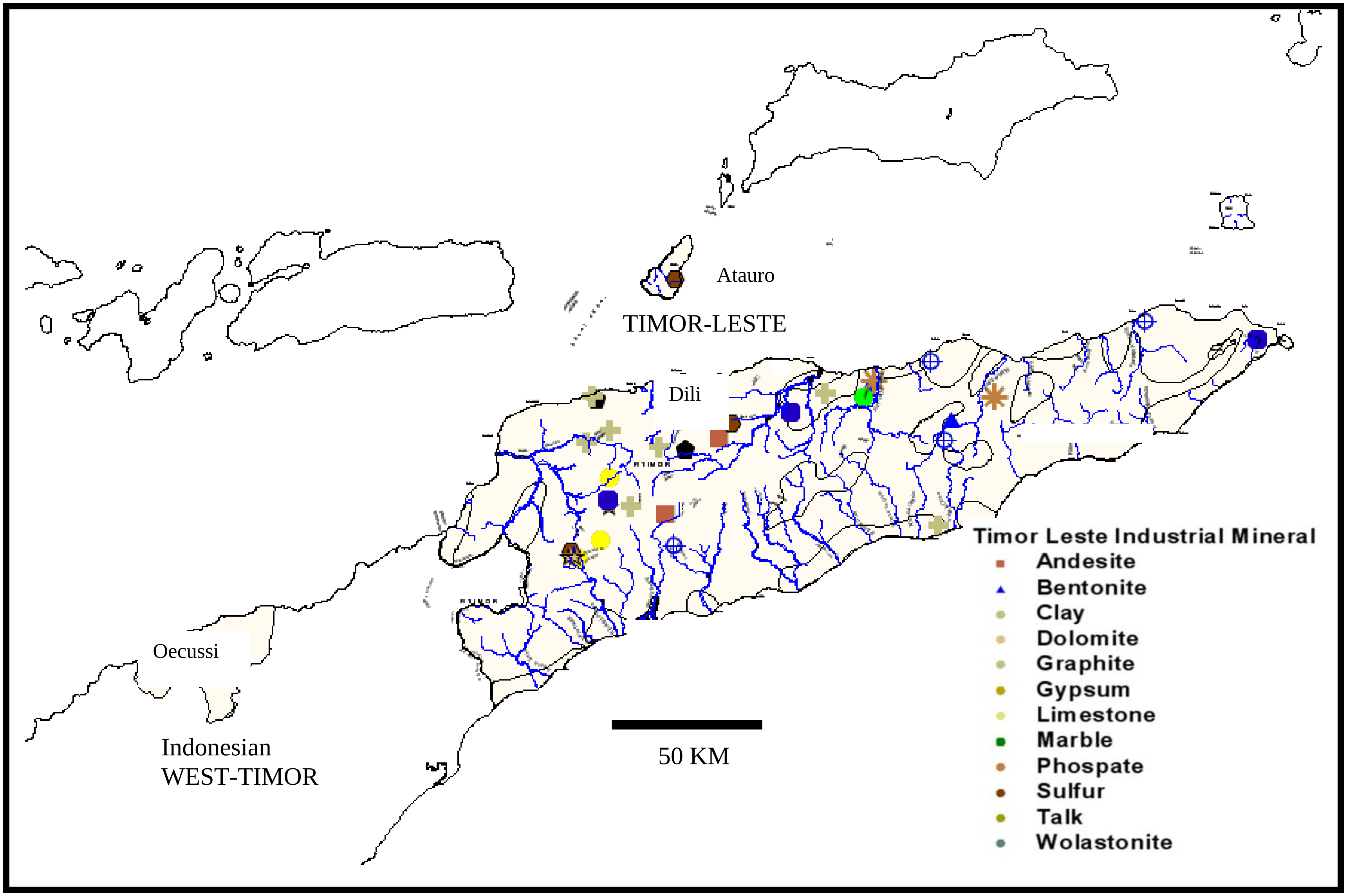

Figure 6. The distribution of non-metallic minerals in Timor-Leste

3. Legislation

Timor-Leste has numerous occurrences and deposits of a wide spectrum of industrial minerals, construction materials, base metals and precious metals and stones. All of these offer present and future opportunities for strengthening employment, infrastructure and government revenue but also pose certain threat to environment if they are not explored and developed in a sound mining practice and environmentally friendly manner. Therefore, it is very important that the Government stipulate a legislation from which every party involves can follow. In this regard, the national mineral policy legislation and regulatory framework, the technical draft of the Mines and Mineral Management Law (MMML) has been prepared by an UN SCAPE and is to be studied by the Government Legal Draftsman prior to the submission to the parliament for legislation and is due to be approved by probably mid next 2004. The draft is intended that the government will adopt and implement a mineral policy that will allow for the ***responsible and profitable*** exploration and exploitation of its mineral resources.

Mining License

It has been recommended that ***only one formal document***, a Mining License, be required for a successful applicant to secure the right to conduct exploration and mining activities.

Tax

Tax considerations are required under an ***Investment Stabilisation Agreement (ISA)***. The main function of the ISA is to negotiate the ”freezing” of certain tax, fiscal and legal provisions over fixed periods of time in the large-scale mining project.

Environment Protection

It has been recommended that the mining law specify social responsibility imperatives as an *integral part of work programmes* to be registered annually by mineral license holders.

Community Partnerships

It has been recommended that where exploration activity identified a commercially viable mining operation, provisions are made for the creation of a formally constituted

Sustainable Mining Development Authority (SMDA) consisting of a cooperative partnership of the Government appointees and representatives of the local community, the district and the mineral holder's management team.

Capacity Building

It has been recommended in the interest of capacity building in the natural and mineral resources sector that exploration and development work should include obligatory training and education in the mining projects. Successful projects should deliver well-trained and educated technical personnel during and at the end of the project's life.

Institutional Development

It has been recommended that to advance the Government planning for department structure and capacity building, the Government designate a new or existing Department to include a Geological Survey and Mines Division and Oil and Gas Division.

Registrar

It has been recommended that the Government recruit and appoint a "Registarar" to begin the research and preparation of a National Mineral Rights Registration System (NMRRS).

4. Conclusion

Geologically Timor is controlled by the collision in Middle-Miocene to Mid-Pliocene between Australian continental plate and Banda arc plate (Asia microplate). This collision has emplaced thrust sheets including the ophiliotes that host the a number of important minerals. Potential metallic minerals in Timor-Leste are gold, copper, chromite, manganese, and silver. Non-metallic minerals are widely distributed, namely, sand, gravels and other aggregates for construction materials, clays for bricks, marble for ornaments, etc.

Timor-Leste is still at a very early stage in the formation of the infrastructure, institutions, human resource capacity and legislation that can support the full control of its natural and mineral resource. The draft of mineral law has just been sent for review by the Council of Minister before it can be brought to the parliament for final approval. However, as it is in the policy of the Government to protect the environment as much as possible, and at the same time promote a good business environment that encourages more private investment. The law is very flexible but does emphasise the importance of an environmentally friendly and sustainable mining practices. The Investment Stabilisation Agreement is stipulated as a way to allow Timor-Leste to be more competitive. The planned Mine Reclamation Guarantee Trust Fund document as one of the condition that should be submitted prior to the development of a prospective area is a way to make sure the environment reclamation will fully implemented at the end of the project life.

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