MINERAL POTENTIAL WITHIN EACH ZONE

Based on the available technical data the area for metallic and minerals other than construction materials are divided into seven (7) zones (Figure 2). A brief summary of each zones and its minerals potential as discussed below.

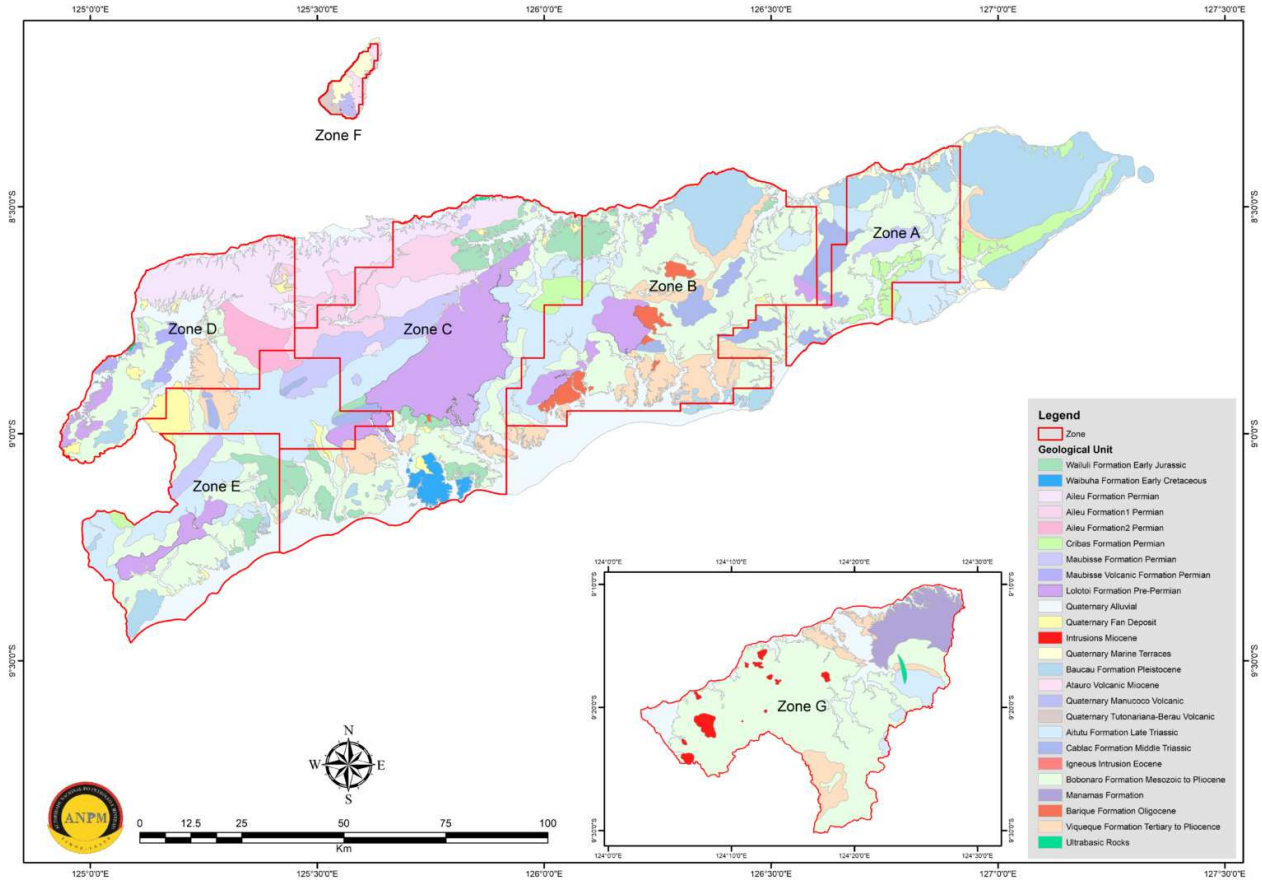

Figure 2: Geological map of zones for metallic and minerals other than construction materials Mining Activities within the territory of Timor-Leste and the protected areas within the territory (Data sources: KARVAK 2022).

Zone A

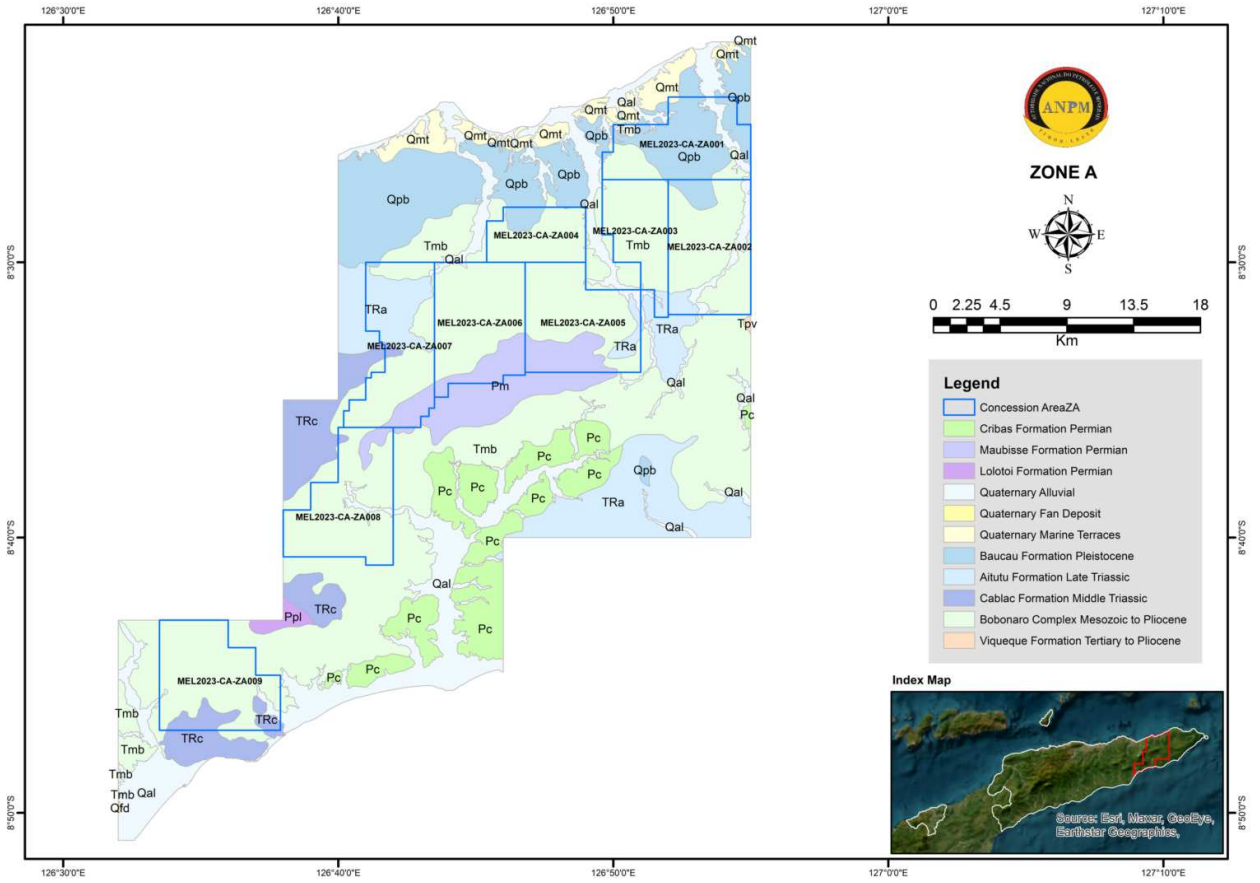

Figure 3: Geological map of Zone A with the concession areas on offer (Geological map is adapted from KARVAK 2022).

Zone A is located mainly within the area of Lautem Municipality and small part of the Viqueque and Baucau Municipalities with the estimated total area of 1114.65 km^2. It has a total of nine (9) concession areas on offer for tender. The surface geology of this zone is primarily consist of Bobonaro Complex, Baucau Formation, Aitutu Formation, and Cablac Formation, with minor Lolotoi Formation, Maubisse Formation, Quaternary Alluvial and Quaternary Marine Terraces deposit (Figure 3). The lithologies that made up these formations are mainly sedimentary rocks such as limestone, sandstone, and marl, while the Bobonaro Complex contain various type of rocks of varying ages in scaly clay matrix.

Rock formations such as the Bobonaro Complex and Maubisse Formation are associated with high magnetic anomalies within the zones. The high magnetic anomalies correspond to the indication of potential metallic minerals and igneous rock present within the zone. Previous studies had noted that Zone A has indication for potential for minerals such as gold, chromium, manganese, and iron sand in part of the area including non-metallic minerals such as limestone and marble (UN-ESCAP 2003, IPG 2020; KARVAK 2022).

Zone B

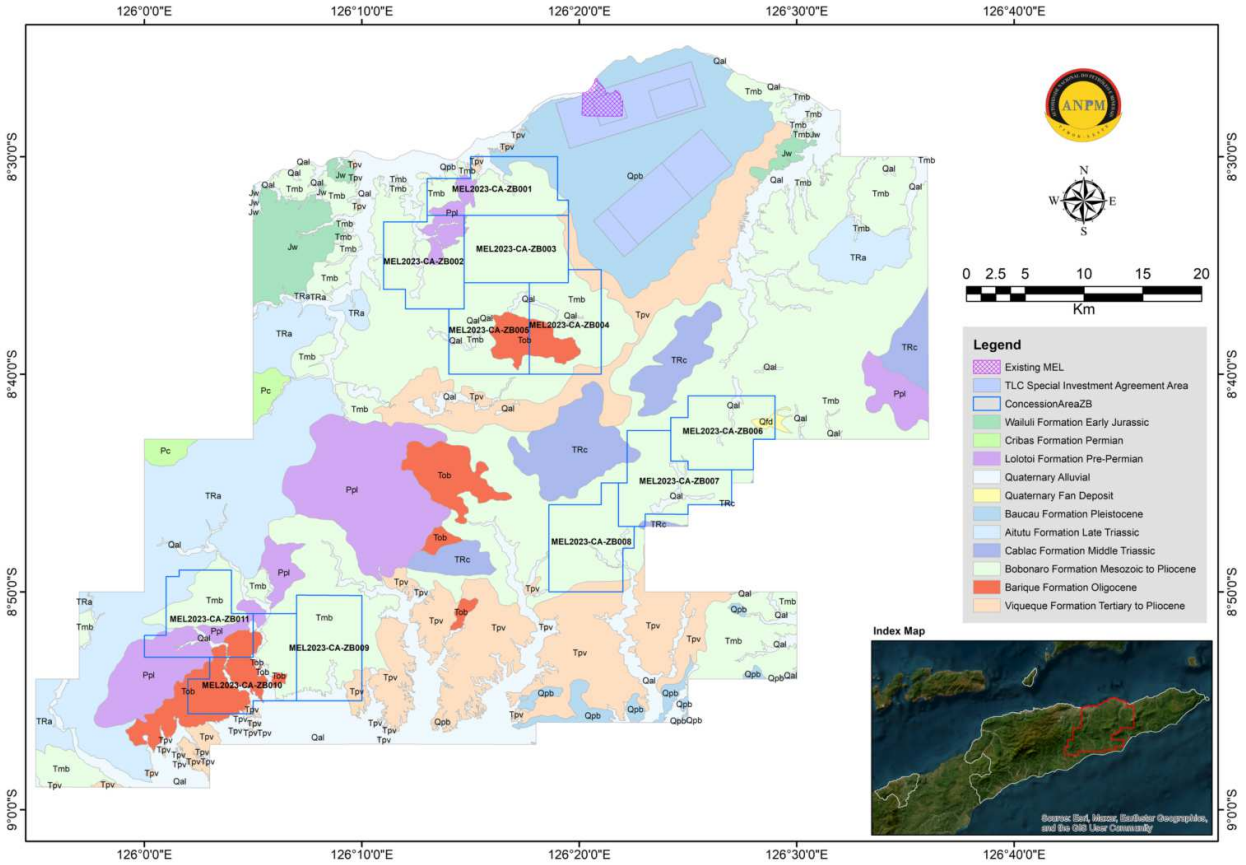

Figure 4: Geological map of Zone B with the concession areas on offer (Geological map is adapted from KARVAK 2022).

The area for metallic and minerals other than construction materials Mining Activities within Zone B has an estimated total area of 2,880 km^2 and covered area of Baucau, Viqueque, and Manatuto Municipalities. This zone has a total of eleven (11) concession areas on offer for tender. The area within Zone B composed of lithologies mainly from Bobonaro Complexes, Baucau Formation, Viqueque Formation, Aitutu Formation, Lolotoi Formation, and Cablac Formation, with some minor Barique Formation, Wailuli Formation, Quaternary Alluvial and Quaternary Fan Deposit (Figure 4). Previous studies carried out in this zone has shown that there is indication for metallic such as copper, manganese, chromium, zinc, gold and silver, including non-metallic minerals such as gypsum, limestone, marble, dolerite, and basalt (UN-ESCAP 2003, Lay et al. 2017, IPG 2020; ANPM 2022a, b).

Copper associated with gold are the most notable metallic minerals within this zone based on the previous studies. Copper minerals observed within this zone exists as two different types based on the observation in the field. The primary copper mineral, crystallised as chalcopyrite that was found in some area within Baucau Municipality, is associated with sphalerite; and secondary copper minerals occur as malachite, chrysocolla and rarely azurite. The mineralisation is typically occurred in association with quartz-carbonate veins, or hosted directly within serpentinites or igneous rocks within the area. It is suggested that the likely mineralisation styles for the copper, gold and its associated silver is the Cyprus-type volcanogenic massive sulfides (VMS) related to Ophiolites for mineralisation in Ossu area (UN-ESCAP 2003). The copper mineralisation within the Baucau Municipality area has been noted as early as in 1937 by the work of Allied Mining Corporation.

Zone C

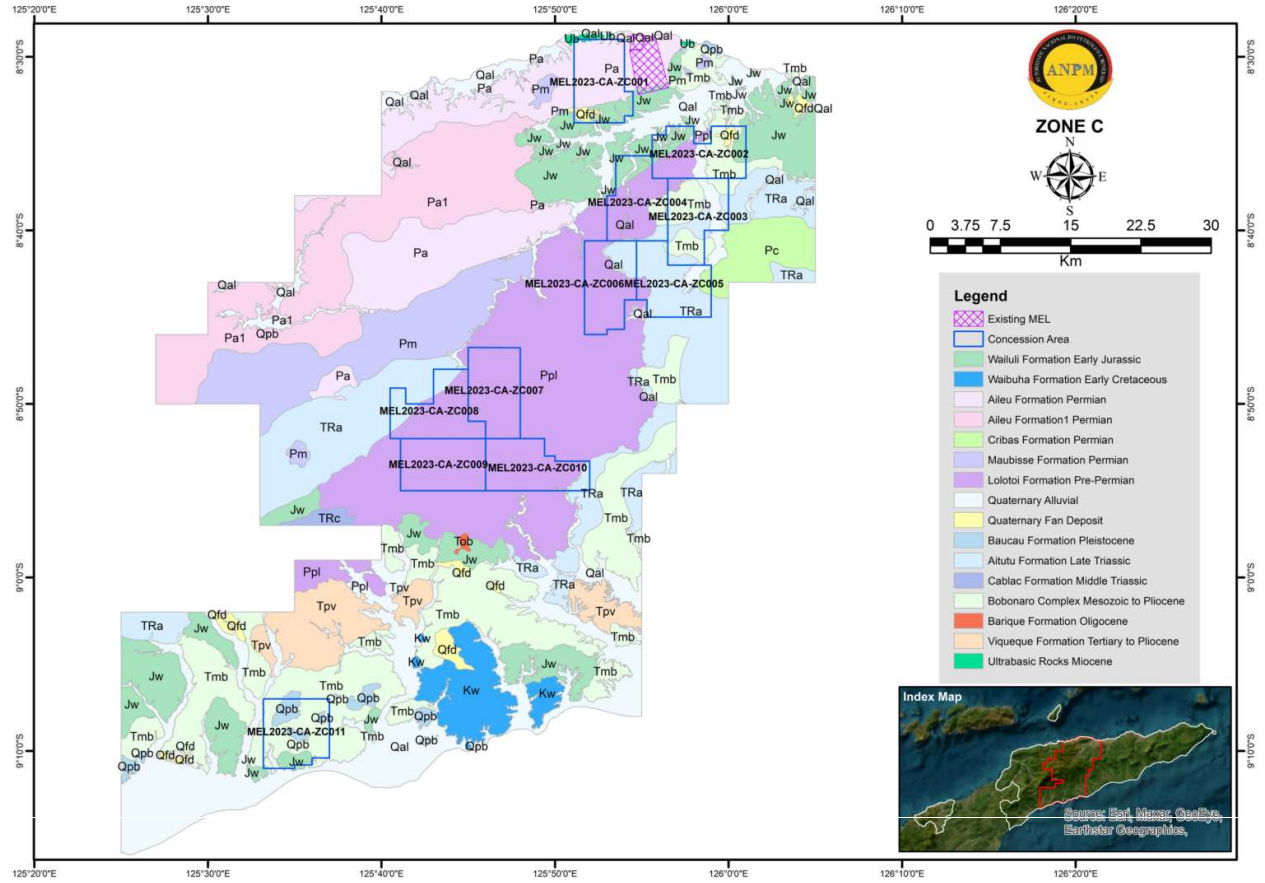

Figure 5: Geological map of Zone C with the concession areas on offer (Geological map is adapted from KARVAK 2022).

Zone C is the largest zone for metallic and minerals other than construction minerals Mining Activities covering few municipalities, such as Manatuto, Aileu, Ainaro, and Manufahi Municipalities, as well as part of Dili Municipality in the Metinaro area and Ermera Municipality in the Letefoho area with a total estimate area of 3,716 km^2. This zone mostly contained high magnetic anomalies corresponding with the Aileu Formation, Lolotoi Complex, and Maubisse Formation (Audley-Charles 1968; KARVAK 2022). The indicated mineral potentials within Zone C from previous studies were chromite, manganese, gold, and copper for metallic minerals (AMC 1937; UN-ESCAP 2003) and bentonite, limestone, marble, and some clay mineral resources for non-metallic minerals (UN-ESCAP 2003).

The occurrence of chromite, the chromium ore, within Timor-Leste has been confirmed to be present at Manatuto Municipality hosted within the Aileu Formation, particularly within the peridotite (ranging from lherzolite, harzburgite, and dunite) and their serpentinite equivalent at varying degrees of serpentinization (Lay et al. 2017). The chromite is associated with minute traces of platinum-group elements (PGEs). Additionally, traces of copper and nickel mineralisation was also identified in the area to be associated with this chromite (Lay et al. 2017). Apart from the Illimanu area, Turiscai area of Manufahi Municipality was also identified as one of the area in which there is an indication of precious and base metals based on the previous studies (AMC 1937; UN-ESCAP 2003). The gold reported to occur within quartz vein or as gold nuggets found to be associated with gravel in sections of the Sue, South Laclo and Cler Rivers, suggesting a placer gold deposit occurring within the Manufahi Municipality (AMC 1937; UN-ESCAP 2003). Aside from gold mineralisation mentioned, disseminated copper- gold and copper mineralisation also found in ophiolite sequence similar to copper mineralisation in other part of the country, particularly those identify in Baucau and Viqueque Municipalities (UN-ESCAP 2003).

This zone is also noted for its kaolin deposit and identified as the largest indicated resource for kaolin within the country, within the municipality of Aileu (UN-ESCAP 2003; IPG 2017). Other non-metallic mineral such as phosphate also occur within Zone C, particularly within the Manatuto Municipality hosted by the Bobonaro Scaly Clay. Currently there are two existing concession areas located in Manatuto Municipality within Zone C (Figure 5).

Zone D

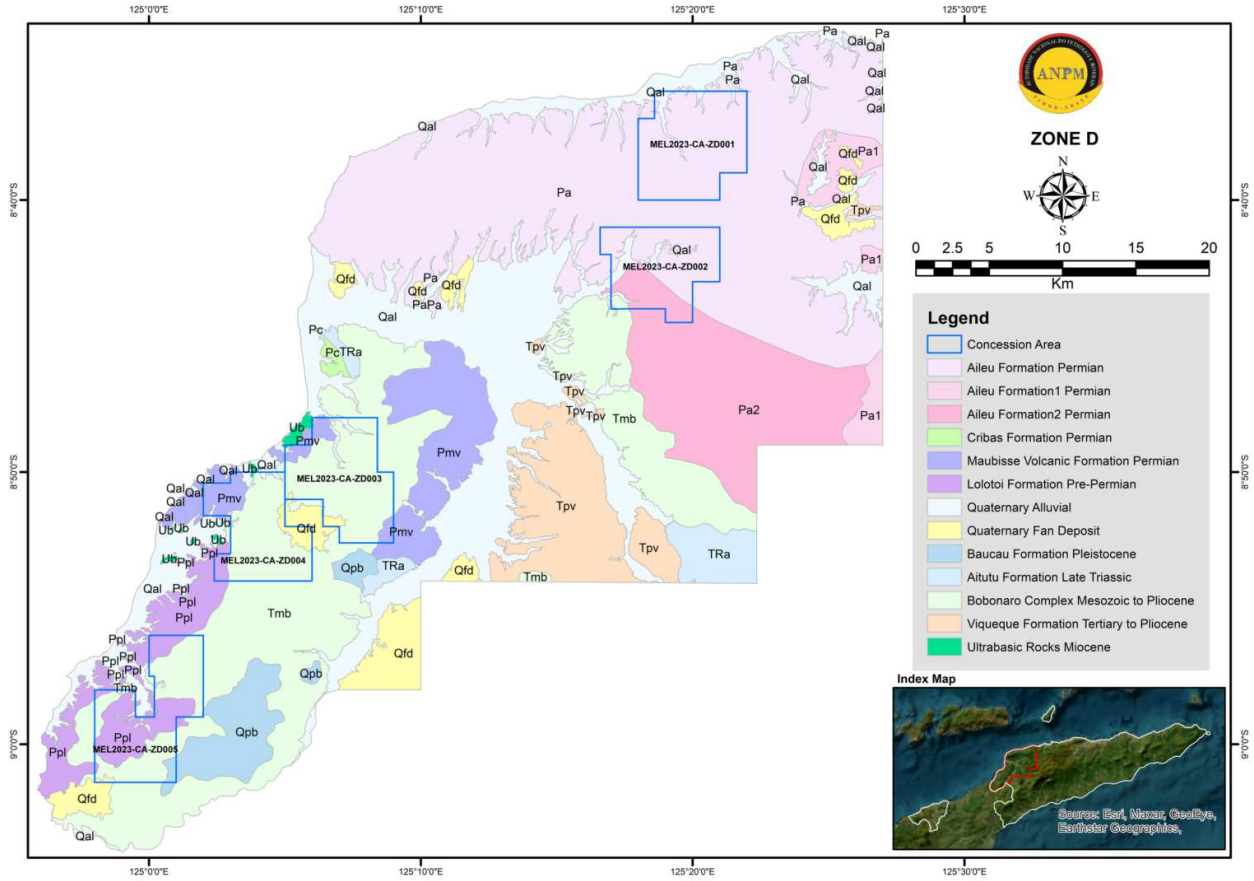

Figure 6: Geological map of Zone D with the concession areas on offer (Geological map is adapted from KARVAK 2022).

Zone D is mainly located within the Liquiça, Ermera, and Bobonaro Municipalities with a total estimated area of 1593 km^2. This zone has a total of five (5) concession areas on offer for tender. The area of Zone D is mainly covered with the Aileu Formation, Bobonaro Complex, Maubisse Volcanic Formation, Viqueque Formations, Lolotoi Formation, Quaternary Fan Deposit, and Quaternary alluvial, with minor Baucau Formation and Cribas Formation (KARVAK 2022).

The indicated minerals within this zone are gold, copper and manganese (UN-ESCAP 2003; IPG 2015, 2016, 2020). The indicated gold mineralisation within the Ermera Municipality is noted to be associated with copper and found in the area of Letefoho (UN-ESCAP 2003). Whilst the gold mineralisation within the Liquiça Municipalities area found as minute gold grain associated with sand and gravel as potential of alluvial gold (IPG 2015, 2016).

Aside from the metallic mineralisation, there a few localities within Zone D in which there is an indication for non-metallic minerals, such as clay, limestone, and potential bentonite, marble, and gabbro especially within the Bobonaro Municipality (UN-ESCAP 2003). Not many studies focusing on exploring the metallic and non-metallic mineral resources within this zone was carried out, hence there is a lack of detail data in the area.

Zone E

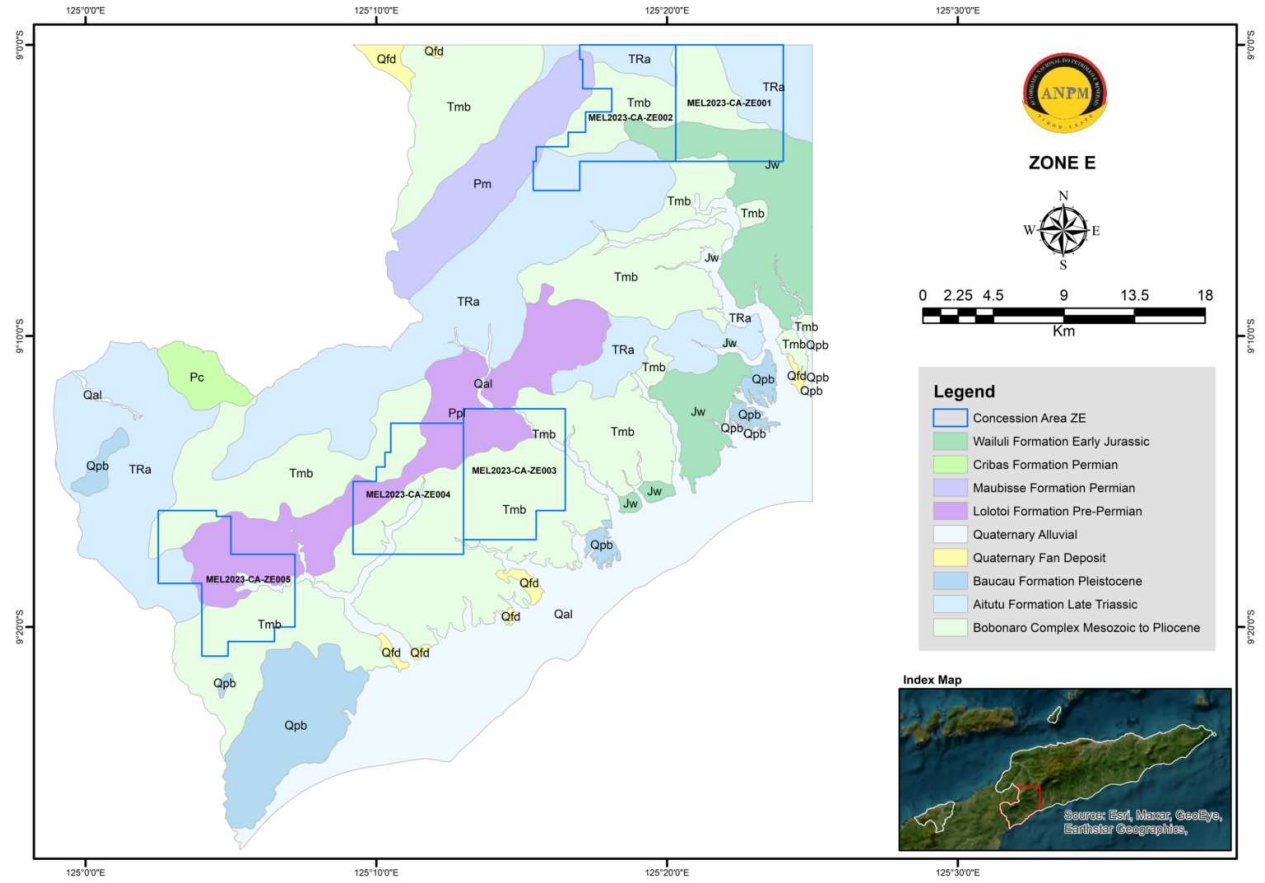

Figure 7: Geological map of Zone E with the concession areas on offer (Geological map is adapted from KARVAK 2022).

Zone E is located mainly within the Bobonaro and Covalima Municipalities and small part of Ermera Municipality particularly within the Atsabe area with a total estimated area of 1,431 km^2. Zone E is mainly covered by three formations, i.e., the Lolotoi Complex, Aitutu Formation and Bobonaro Complex with minor Wailuli Formation, Maubisse Formation, Baucau Formation and Quaternary Alluvial as well as Quaternary fan deposit (Figure 7).

The indicated metallic minerals within this zone, are gold and copper, as well as non-metallic mineral such as limestone, potential marble, dolomite, and bentonite in the area (UN-ESCAP 2003). Similar to Zone D, very little studies focusing on the exploration for minerals was carried out in Zone E, resulting no detail data relating to the indicated mineralisation.

Zone F

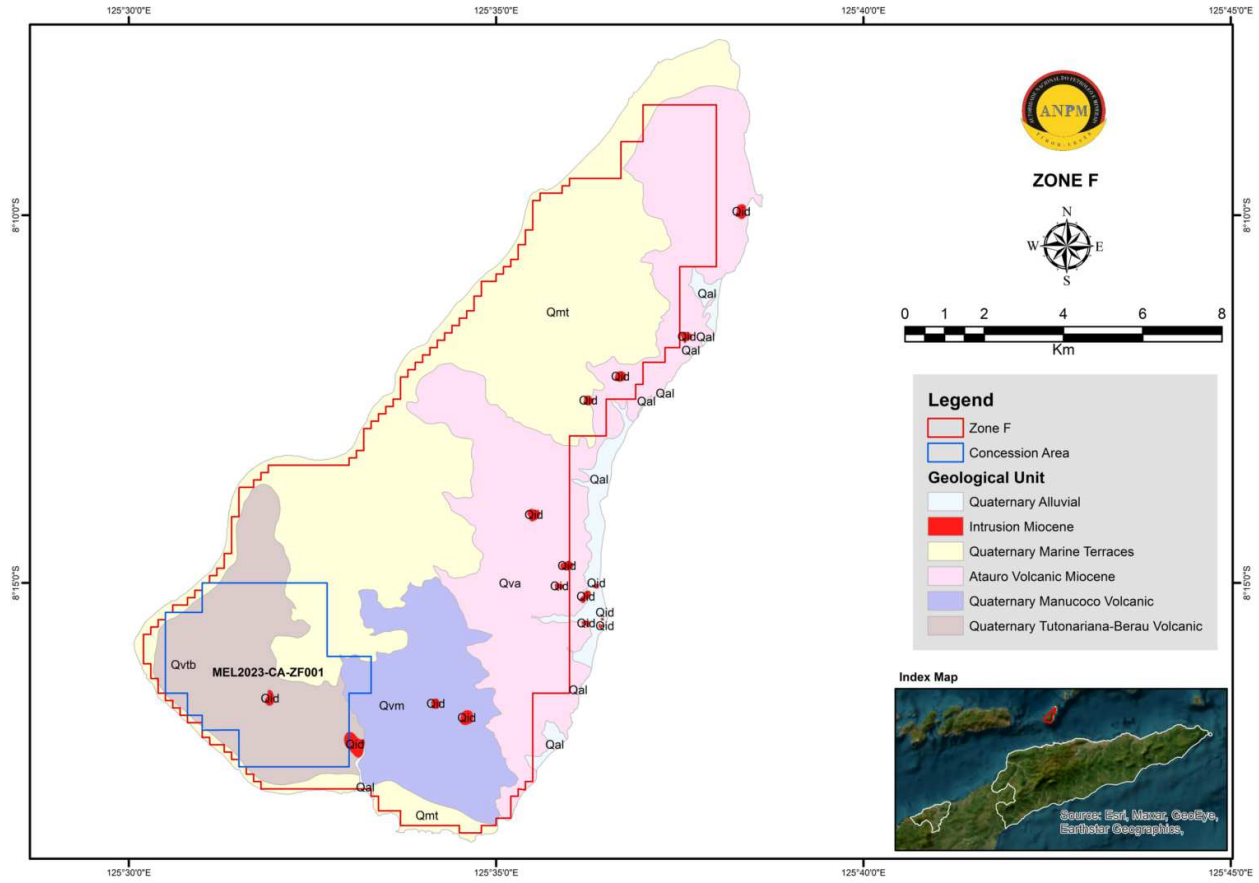

Figure 8: Geological map of Zone F with the concession area on offer (Geological map is adapted from KARVAK 2022).

Zone F is located within the Atauro Island, the 14th municipality of Timor-Leste. This zone has a total estimated area of 116 km^2 (indicated within the Zone F boundary). The lithology and process of the formation of the Atauro Island is different than the Timor Island as Atauro is part of inner volcanic arc of Banda Arc. The geology of the Atauro Island based on the reinterpreted map from KARVAK (2022) are mainly covered with three different type of volcanics, i.e. Manucoco, Tutonariana-Berau, and Atauro Volcanics, as well as Marine terraces (Figure 8). The Tutonariana-Berau Volcanics, which consist of breccia, tuffs and some lavas as in KARVAK (2022) corresponded to clinopyroxene-phyric basaltic andesite and limestone based on the Ely et al. (2011) geological map. The north-eastern side lithology which interpreted as the Atauro Volcanics (KARVAK 2022), corresponded with dacite (Ely et al. 2011).

Based on the previous studies there is an indication of metallic minerals such as gold, silver, and manganese (UN-ESCAP 2003), as well as copper (KARVAK 2022), and non-metallic mineral such as limestones and potential kaolin (UN-ESCAP 2003) within this zone. No detail studies have been carried out in the island to explore for metallic minerals, however as Atauro is part of the inner volcanic of Banda Arc, it is suggested that the mineralisation is most likely is hosted by epithermal style mineralization and also has potential for VMS type deposit as its neighbouring island, Wetar Island. The copper mineralisation observed within Atauro occurs as secondary minerals such as malachite associated with tuff (KARVAK 2022). Majority of these indicated mineralisation is associated with the volcanic rocks within the area (UN-ESCAP 2003; KARVAK 2022).

Zone G

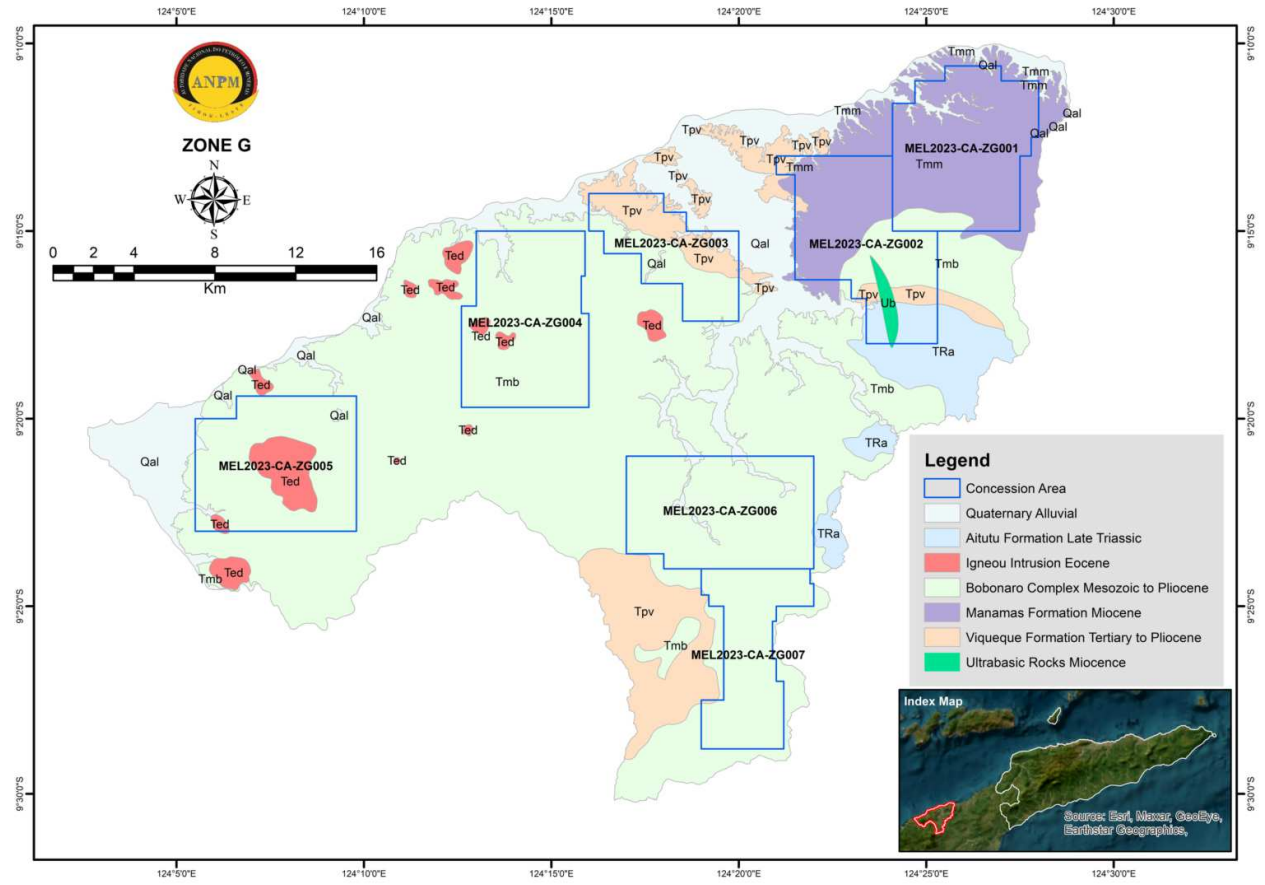

Figure 9: Geological map of Zone G with the concession areas on offer (Geological map is adapted from KARVAK 2022).

Zone G covers entire area of the enclave, Special Administrative Region of Oe-cusse-Ambeno (RAEOA) with an estimated total area of 814 km^2. The geology of this zone consist of seven different formations namely the Bobonaro Complex, Manamas Formation, Viqueque Formation, Aitutu Formation, Igneous Intrusion, Ultrabasic rocks, and Quaternary Alluvial (KARVAK 2022).

There are a number of metallic and non-metallic mineral indicated within this zone, such as gold, copper, manganese, gypsum, bentonite and limestone (UN-ESCAP 2003). The gold mineralisation within this zone is most likely associated with the volcanic rocks of Manamas Formation, however further detail exploration work need to be carried out to confirm this.

No detail mineralisation study has been carried out within the zone for their economic potential except for manganese exploration. The manganese exploration work carried out by PEM (2020) in Zone G particularly in Nipane and Passabe area shown that there is indeed manganese deposit within these areas, occurring as manganese fragment in chert boulder, manganese layers and manganese nodules (PEM 2020).

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