Preliminary Study on Ground-Magnetic Data Near the Active Volcanoes in Konga Bay, East Flores Indonesia

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Abstract. East Flores is part of Nusa Tenggara island belongs to volcanic arc zone, hence the active volcanoes surround the area about 60 x 50 square km. It is located at latitude south 8° 30', and longitude east 122° 45'. Geologically, the rock is mostly of volcanic material since Miocene age. The intriguing question is where the volcanic feeder, pyroclastic, and how it vanish in subsurface. The magnetic data acquisitions were executed on land for 500 meter interval and denser through the bay surrounded by volcanoes. The combine reduction to pole and forward modelling is apply for serve interpretation using forward modelling technique. The two interpretation sections, show the body of magmatic may present at depth about 2 to 3 km. The observation show no significant decreasing or loosening of magnetic anomaly although near the active volcano. We suggest the thermal anomaly is just disturbing magnetic data in near surface but not in the depth one. Meanwhile the reduction to pole's section could distinguish the two group of rock. In assuming the layer is flat. The inferred peak of magmatic body near the existing volcano; and the active demagnetization associated through evidence of hot spring and inferred fault structure.

1. Introduction
East Flores is one of several chain of volcanic arc in Nusa Tenggara (South East islands) Indonesian, close to Bali and Lombok islands. It is on latitude south 8° 30', and longitude east 122° 45'. The island, tectonically is part of magmatic arc of Pacific's ring of fire, about 300 km from Indonesian subduction zone. The uniqueness, the small islands is encircled by volcanic product, and oceans: Indian Ocean in south, and Flores and Banda seas in North.

The magnetic data apply on this islands, for study of volcanic product, the magma feeder and the anomaly for its association using proton magnetometer. Because of dipolar magnetic and position in near equator, the qualitative interpretation will slightly hard. From here, the reduction to pole (RTP) idea [1][2][3] is apply for distinguishing anomaly and more distinct feature in subsurface. To interpret causative body use forward modelling technique. The coverage area is about 50 x 60 square km, and the magnetic data acquire along the existing road about 500 m interval and on the sea.
2. Geology of Konga bay
The study area is surround by volcano due to plate tectonic position in volcanic chain. Two main structure exist on this area. It is, the Miocene of strike slip fault, and the Pleistocene of normal fault in NW-SE and SW-NE.

The whole lithology [4][5], is mostly volcanic product, sometimes found marl, and the combined coral -beach sand. The oldest known rock crop out on this area is known as Kiro Formation (Tmk), Miocene age. It consist of product of lava, breccia, sometimes and sandy-tuff with composition of andesite until basalt.

The volcanic product of pyroclastic from Nangapada (Tmn) to Waihekang (Tmpw), is break by an intrusion of Wolowaru (Tmg) Formation of Middle Miocene. The most subtle and well-known is the old volcanic product (Pleistocene) and young volcanic product (quaternary). These two found in most volcanic Indonesian rock.

The quaternary-Pleistocene volcanic product consist two unit, the Quaternary Pleistocene Volcanic Product (QTv). It is consisting of Breccias, interbred sandy tuff with pumice or breccias tuff, and agglomerate. While the Holocene Volcanic Product (QHv) consisting lava of breccias, sandytuff. The QHv is found near the recent active volcano.

3. Reduction to pole and magnetic anomaly identification
The Reduction to pole (RTP)[1][2][3] is a method in magnetic interpretation to recognize the subsurface anomaly in case a complex or hardly identify the obscure subsurface object due to its dipolar responds. This formula apply for dipolar magnetic data near equator, transformed as it will be in polar position to easy interpretation in unique mono polar pattern. The original magnetic data $T(O)$ in coordinate polar $(\rho, \omega)$ and inclination factor: $i, \mu$, could be transformed to reduction to pole $g'$ result, $g'$, as:

$$g' = -\mu T(\omega) - \frac{1}{2\pi} \iint T(\rho, \omega) \Omega(\omega) \frac{d\rho}{\rho} d\omega$$

Figure 1. The reduction to pole to distinguishing anomaly, and the result is more distinct.
The following synthetic data show the effectiveness of reduction data in interpretation two closed object 2 km separation and 0.5 km depth. The curve show dipole pattern from the two object, and we are slightly speculation to decide. The reduction to pole pattern show the centre position of object, and it is on the flank of original data. We can simulate many possibilities for the object composition and the complexities of the pattern.

4. Interpretation two sections near the volcano

The magnetic data on this interpretation has deduced from unwanted effect of earth magnetic field and atmospheric disturb, applying IGRF formula and daily magnetic on base. Hence the result is magnetic represent the subsurface object only. The middle range of measurement of about 45600 nT, is reduced by IGRF, and the result is magnetic data ready to interpret on the range 1200 nT until 1400 nT. The interpretation use forward modelling technique software.

4.1 AB Line

The AB cross section is a magnetic line in SW-NE where it is through almost volcano Ille Berapan, Flores strait, Oka bay, and the volcano Ille Mandiri. This interpretation line is also through the volcanic deposit of quaternary (QTv), and the lineament's interpretation from Landsat near Oka Bay.

The anomaly show the depth magnetic effect (2500 meter), due to plutonic influence. The respond of reduction to pole is locally narrow low, near Oka bay. While in the adjacent curve and the magnetic data show the appearance double source of positive anomaly. The field evidence show near the center of anomaly in Oka bay found the hot spring, and on the Landsat map show the lineament. However, We guess the narrow low curve of reduction to pole is due to demagnetization by the existence of hot fluid, or mineralization among the (extinct) plutonic body (k=0.001). And, beneath the volcanic rock (K=0.005) consisting young andesit Formation.
4.2 EF Line
The EF section is crossing the profile AB. The two peak of anomaly as well as RTP show the possible evidence of a magmatic body. The SW vicinity is similar to AB section where we interpret the magmatic body beneath the Flores strait extend to this point. While in east vicinity, the Ili Boleng show up the volcano activities, but not present the strong demagnetization. This case is similar to other section where the effect fairly small representing by anomaly curve. But the plug as dyke maybe present strong magnetic such case Ili Boleng.

The RTP curve show the wide negative as well as the magnetic curve and it is related to volcanic rock of Kiro Formation. Hence these two curve could distinguish the volcanic rock of Kiro Formation (The oldest rock), from the others. The emergence the old Kiro Formation among the young in nearly flat sedimentary, means the throw is taken place. The body is either a horst or horizontal displacement. And now, Kiro Formation is evidence of Hiatus until recent years.

![EF Line Interpretation](image.jpg)

Figure 3. The EF section Interpretation. The old Kiro Formation show the combination of low magnetic and low RTP anomaly. Ili Boleng, an active Volcano show the peak anomaly.

5. Conclusion
At Konga bay, around volcanic product, the combination of Magnetic anomalies and the reduction to pole could distinguishing the body of plutonic by model of the plug, the oldest rock (Kori’s Formation) from younger one. Meanwhile, the alteration is reveal by demagnetization around dominant high magnetic value.

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