EAST JAVA

The physiographical and tectonical zones of the eastern spur of Java and the Island of Madura can all be traced westward into East Java. In East Java, extending from Surabaja to Semarang, we find from South to North (compare fig. 256a):

1. The Southern Mountains.
2. The Solo Zone, subdivided into:
   a. the Blitar Subzone.
   b. the Solo Zone *sensu stricto.*
   c. the Ngawi Subzone.
3. The Kendeng Zone.
4. The Randublatung Zone.
   (3 + 4 are the westward extension of the Strait of Madura Zone).
5. The Rembang Zone.
6. The Semarang-Rembang depression.
7. The Muriah Complex.

Fig. 265 gives a schematical picture of the geology of the western part of East Java and the adjoining part of Central Java.

A more detailed picture of the geology of the Surakarta area is given by fig. 268 on pl. **34**, and the corresponding sections are found on fig. 269 on pl. **28**.

1. THE SOUTHERN MOUNTAINS OF EAST JAVA

The Southern Mountains of East Java are best studied in the area South of Surakarta and Klaten (see fig. 266 on plate **33**). The Southern Mountains can be divided into a southern part, the limestone plateau with Karst-topography of the Gunung Sewu (= "Thousand Mountains"), and a northern part, composed of mountain ranges (the Gunung Kidul or Baturagung Range, the Panggung Massif, the Plopoh Range, and the Kambengan Range). The southern and northern part of the Southern Mountains are separated by the intermontane basins of Wonosari and Baturetno.

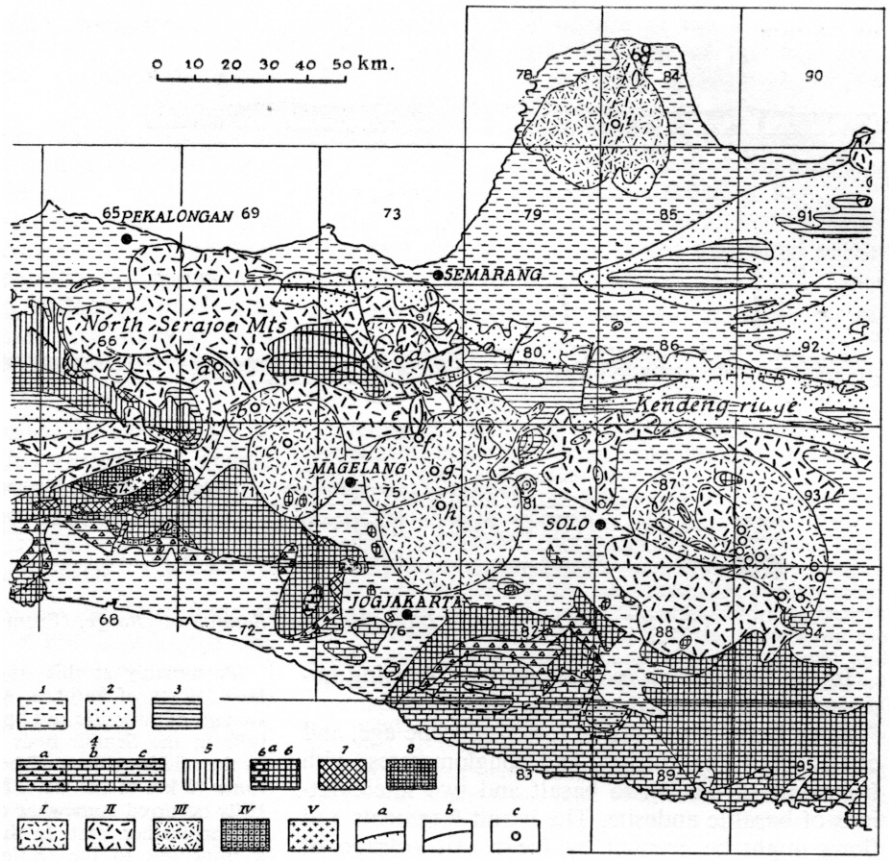

FIG. 265. *Geological sketchmap of the transitional area between East- and Central Java.*
(From VAN BEMMELEN, 1943, fig. 24a, p. 89)

Sedimentary formation

1 = Alluvial.
2 = Plio-pleistocene deposits
(in the Kendeng ridge this shading comprises the Lower- and Upper Kalibeng, Putjangan, and Kabuh stages).
3 = Mio-pliocene deposits
(in the Kendeng ridge this shading comprises the Kerek and Banjak Beds, and in the North- Seraju Mts the basal volcanic layers of the Bodas Series).
4 = Younger part of the Miocene in the Southern Mts:
a. (Lower) : volcanic breccias of the Ojo Beds;
b. (Middle) : Wonosari limestones;
c. (Upper) : Kepek marls in the basins of Wonosari and Baturetno.
5 = Older part of the Miocene in flysch facies (Merawu Series of the North-Seraju Mts).
6 = Older part of the Miocene (and upper Paleogene?) in the volcanic fades (Southern Mts; South Seraju Mts; Penjatan Beds in the North-Seraju Mts).
6a = Lower-miocene Djonggrangan limestones of the West-Progo Mts.
7 = Eocene (Djiwo, Loh Ulo in the South-Seraju Mts, Karangkobar in the North-Seraju Mts).
8 = Pre-Tertiary.

Volcanic rocks:

I = Holocene volcanic cones.
II = Upper-pleistocene volcanic deposits (Notopuro Beds, Djembangan Complex in the North-Seraju Mts, Old Ungaran, Soropati, Old Lawu, Lasem, Butak).
III = Middle-pleistocene Muriah volcano with a potassic (Mediterranean) suite of rocks.
IV = Intra-miocene basalts in the South-Seraju Mts (Second Breccia Horizon of sheet 67).
V = Intra-miocene gabbro-diorite intrusion of the South-Seraju Mts (Loh Ulo).
a = Up- and overthrusts;
b = Normal (slip-)faults and transverse faults;
c = Young quaternary centres of eruption:

a. Dieng; *b.* Sundoro; *c.* Sumbing;
d. Ungaran; *e.* Soropati; *f.* Telemojo;
g. Merbabu; *h.* Merapi of Central Java;
i. Muriah; *j.* Lawu.

N.B. The numbers in the quadrangles indicate the numbers of the sheets of the geological map of Java, 1 : 100,000.

FIG. 266 on PLATE **33**. *Geological map of the Djiwo Hills and the Southern Mts (Baturagung- or Gunung Kidul Range).* (From BOTHE, 1929)

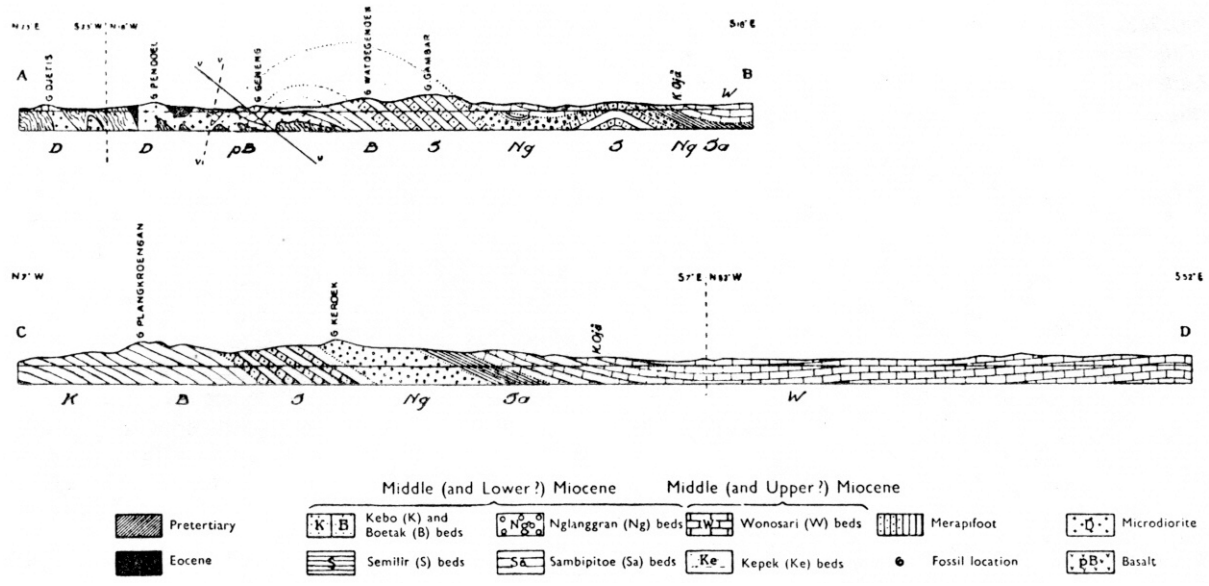

FIG. 267. *Sections across Djiwo Hills and Baturagung Range.* (From BOTHE, 1929)

The Djiwo Hills near Klaten are situated North of the Baturagung Range. These hills belong already to the Solo Zone, being entirely surrounded by the quaternary volcanic deposits in this depressed zone.

The general geological and geomorphological history of the Southern Mts has been discussed by LEHMANN (1936), and a more detailed description of the stratigraphy of the Gunung Kidul was given by BOTHE (1929).

We will first give BOTHE'S stratigraphy, and then continue with LEHMANN'S analysis of the geomorphological history.

Before discussing the stratigraphy of the Baturagung escarpment, first something must be said about the stratigraphy of the Djiwo Hills at its northern foot, as there is a close relation between both. In the Djiwo Hills pre-tertiary and lower-tertiary formations are exposed, which are not found in the Southern Mts of the Surakarta area. These older formations have been intruded by diorite, micro-diorite, porphyrite and basalts. These intrusions are the basal parts (or stock) of a basalt volcano, the eruption products of which are probably present in the lower neogene strata of the Baturagung escarpment South of it (viz. the Kebo and Butak Beds, to be mentioned hereafter).

In the Baturagung escarpment the following horizons are exposed from base to top:

Kebo Beds. These are of lower-miocene age, and consist of shales, tuffites, and conglomerates, with fragments of the Djiwo basalt and two intercalations of basaltic andesite. The basalt fragments and flows might be erupted by the basalt volcano of the adjacent Djiwo Hills. BOTHE supposes a stratigraphical gap between the Djiwo intrusions and the Kebo Beds, but the contact is largely covered by young Merapi tuffs.

The present author is of the opinion that the Kebo- and Butak Beds were formed as the submarine mantle of the Djiwo volcano, and that at the same time the basic-intermediary intrusions of Djiwo reached the surface. This Djiwo volcano was situated on the crest of a median ridge which had been arched up from the eocene geo-syncline (see section II of fig. 267); the Kebo- and Butak Beds were formed on its southern, submarine flank. Thereafter, the Djiwo volcano became extinct and was baseleveled; the overlapping Semilir Beds were deposited during a transgression (see below).

The **Butak Beds** form the next higher horizon, starting with agglomerates of effusive components, interbedded with sandstones and shales. On top of these strata thick tuff breccias form the transition to a series of shales, tuffites and acid pumi-ceous tuff-breccias, called **Semilir Beds.** This horizon is the most conspicuous of all, forming the steep escarpment of the Baturagung Range. This horizon transgressively overlaps the Djiwo Hills in the North, and contains at its base debris of micro-diorite, schists and eocene rocks.

Therefore, only during this stage the Djiwo Hills with the microdioritic intrusions were exposed by erosion, thereafter they subsided again below sea-level.

Presumably at this stage the eruption centres farther East (North of Patjitan) were domed up and intruded by swarms of andesitic and liparitic dikes. The acid pumiceous tuffs in the Semilir Beds might be the efflata produced by the acid intrusions of the area North of Patjitan, situated some 40 km to the East. If so, the elevation of the Djiwo Hills occurred somewhat earlier than that of the Patjitan section farther East. In this respect the Djiwo Hills form a transition to the section of Central Java, where the whole neogene sequence of events occurred at successively earlier dates than in East Java (see for example the sub-chapter on the West-Progo Mountains).

The next horizon, consisting of poorly stratified agglomerates (**Nglanggran Beds**), forms the transition to a series of sandstones and shales, called **Sambipitu Beds.** In the latter the following larger Foraminifera were determined, indicating on middle-miocene age:

Lepidocyclina (Nephrolepidina) verbeeki NEWT. & HALL.
Lepidocyclina (Nephrolepidina) jerreroi PROVALE.
Lepidocyclina (Nephrolepidina) sumatrensis BRADY.
Cycloclypeus communis MARTIN.
Miogypsina polymorpha RUTTEN.
Miogypsina thecideaeformis RUTTEN.

The lower neogene section, exposed in the Baturagung Range of the Gunung Kidul, South of Klaten, has a thickness of about 4000 m. It is possible that during the formation of the Semilir-Nglanggran-Sambipitu stages the old-andesite volcanoes North of Patjitan were above sealevel. They were intruded during that time by andesitic and acid dikes, and their deeper parts were hydrothermally altered (formation of quartz veins with sulphidic ores, such as pyrite, chalcopyrite, sphalerite, galenite in the area of Tirtomojo, Tegalombo, and Slaung). Thereafter, these old-andesite volcanoes were baseleveled.

After the deposition of the Sambipitu Beds also the area South of Klaten emerged, causing a short interval of erosion. This emersion apparently had the character of a vertical oscillation with some slight warping of the older strata.

Thereafter the sea transgressed again. At first the **Ojo Beds** were deposited which are, according to BOTHE[1]), hornblende-andesitic tuff-sandstones, vitreous tuffs (glass-shards), tuffaceous-marls and clays, limestone breccias and conglomeratic limestones. In these beds the following larger Foraminifera were found:

[1] Explanation of sheet 82, Klaten, of the 1 : 100,000 geol. map; unpublished. In the map and sections of 1929 (fig. 266 and 267) the Ojo Beds were not yet distinguished from the Wonosari Beds.