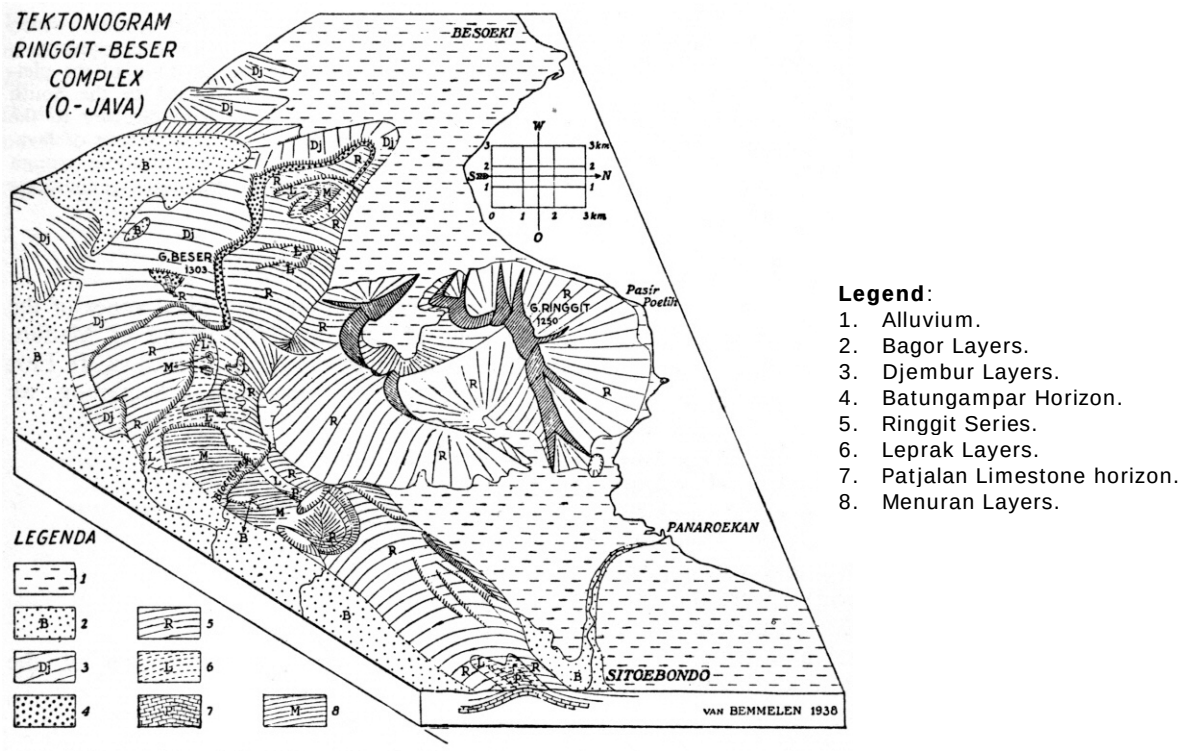
The Beser anticline plunges westward under the alluvial deposits of the coastal plain of Besuki. Farther West the **Lurus complex** also consists of leucite-bearing volcanoes, with later eruptions of hybridic hornblende andesites and biotite trachytes (see fig. 263 on pl. **32**).

There is a report on exposures of marine plio-pleistocene strata on the southwestern side of the Lurus complex, but these have not yet been investigated.



Legend:
1. Alluvium.
2. Bagor Layers.
3. Djembur Layers.
4. Batungampar Horizon.
5. Ringgit Series.
6. Leprak Layers.
7. Patjalan Limestone horizon.
8. Menuran Layers.

FIG. 264. *Isometric blockdiagram of the Ringgit-Beser Complex.* (From VAN BEMMELEN, 1938, p. 184)

Near **Probolinggo,** after a stretch of 40 km of alluvial lowland, some low hills are found, consisting of gently folded young limestones and andesite breccias.

North of the Tengger complex lies the low flat Semongkrong hill, consisting of nearly horizontal tuff layers, cut by an E-W trending fault (see section, fig. 262). The Semongkrong hill or dome perhaps buries a gentle fold in the underlying marine plio-pleistocene strata, as appears to be the case in the Ratji Dome and the Bangil anticline, about 20 km farther West (see fig. 290).

Summarizing the data on the eastern spur of Java the following sketch of its neogene and quaternary evolution can be given:

I. **Lower-Middle Miocene** volcanism (partly submarine).
II. At the end of the **Middle Miocene**, arching up of the Java geanticline and concomitant rise of granite batholiths (Merawan Batholith).
II. After some denudation the geanticline subsided again, so that in the **Upper Miocene** the sea transgressed from the South, and limestones were formed.
III. In the **Plio-Pleistocene**, the geanticlinal area was slightly elevated above sealevel, while along the North coast geosynclinal subsidence continued.
IV. In the **Younger Pleistocene**, volcanism of a Mediterranean composition occurred at the North coast (Ringgit-Lurus), while giant volcanoes of Pacific igneous rocks were built up on the geanticlinal crest (Tengger-, Ijang-, Idjen-Complexes). This strong revival of volcanism presumably accompanied a renewed phase of arching up of the Java geanticline.
V. At **the end of the Pleistocene**, large portions of the Old Tengger, Ijang, and Idjen volcanoes slid towards the low geosynclinal belt to the North, causing there some folding of the plio-pleistocene deposits (Bangil-, Semongkrong-, Beser-anticlines). This compression and folding of the North coast belt compensated the tensional movements by faulting in the Solo Zone.
VI. During **the Holocene** the young volcanoes of the Solo Zone were formed (Semeru, Lamongan, young cones of the Ijang complex, Raung, Idjen, etc.), sealing up and covering the slip-faults, fissures and other tension phenomena of the preceding phase. Also in the northern coastal belt some subrecent volcanic activity occurred (Baluran, Lurus Complex, Grati Maar), situated on transverse faults.

6. THE STRAIT OF MADURA

The Strait of Madura is an eastern extension of the North Java geosyncline, being in a younger stage of evolution. While the sea regressed from the western and central part of the Kendeng Zone (East Java) already in lower pleistocene time, marine conditions were maintened to a later date in its eastern part. In the delta area of the Brantas River (SW of Surabaja) the middle-pleistocene deposits still have a marine fades. The relative subsidence continues to the present day. This follows from the presence in the Brantas delta of black soils formed by subaerial weathering and now found in arthesian drilling cores at depths of some dozens of metres below sealevel. The Strait of Madura itself is a shallow sea with marine sedimentation still continuing up to the present time.

It will appear from the discussion of the Kendeng Zone, that also the folding of the geosynclinal deposits in that zone occurred from West to East at a progressively younger date, until the Strait of Madura is reached, where folding did not yet begin. Only the marginal part of this strait, along the North coast of the eastern spur of Java, was subjected to some folding movements at the end of the Pleistocene. The compression in this marginal belt was directed from South to North.

7. THE ISLAND OF MADURA

(See also the geological sketchmap fig. 5 in Volume II, Economic Geology)

Madura consists of a core of marine (oligo-)mio-cene sediments (Rembang Beds).[1]) These deposits were folded in the Middle Miocene, and then followed a regression of the sea. During the lower Kalibeng stage (Mio-Pliocene) there was some denudation, while in the adjacent Kendeng (= ? Strait Madura) Zone the globigerina-marls of the Lower Kalibeng were deposited. Then followed a transgression of the sea and young pliocene limestones (Upper Kalibeng)[2]) were deposited, followed by lower (+ middle?) pleistocene clays (Putjangan + ? Kabuh Layers) in marine facies. In the youngest Pleistocene the Madura Zone was slightly arched up, and the plio-pleistocene deposits were gently folded. Especially along the southern side of the island some broad synclines and anticlines were formed near Baliga, Pamekasan, and Sumenep. In the southwestern part of the island DUYFJES (1938) mapped slightly asymmetric anticlines with somewhat steeper southern flanks, which indicates that the compressive force was directed from the elevated centre of the island towards the subsiding area of the Strait of Madura, that is from North to South.

The young tertiary and quaternary history of the island of Madura can be summarized as follows:

In the Oligo-Miocene the Madura Zone was subjected to geosynclinal subsidence; the source area of the sediments was the southern part of the Pulu Laut centre of dia-strophism, now covered by the shallow Java Sea. In the younger Miocene gravitational settling caused some folding and regression of the sea; but due to the progressive subsidence the sea transgressed again, and the marine plio-pleistocene series was deposited. Thereafter, the island was arched up, which caused some gravitational reactions in the plastic sediments, as is indicated by the gentle folded plio-pleistocene series.

The island of Madura formed a broad geosynclinal basin together with the Strait of that name during the young Tertiary and Lower Quaternary. However, it is at present a separate tectonic unit (joining on to the Rembang Hills of NE Java to the West and the Kangean Islands to the East). The structural evolution of this Madura belt is dominated by the diastrophism, which spreads from the Pulu Laut Centre of diastrophism.

It is interesting to note that the direction of the pleistocene folding movements were directed to the South in southern Madura whereas they were directed to the North in the North coast belt of the eastern spur of Java. Both directions converge toward the subsiding trough of Madura Strait; this indicates the gravitational character of this folding process.

[1] DUYFJES (1938 b, p. 16-17) mentions from sheet 121 (Baliga) of the 1 : 100,000 geol. map, Tribliolepidinic *Lepidocyciina* sp., *Katacycloclypeus, Cycloclypeus* cf. *eidae* TAN.
BEETS (1944 a) described two new species of *Buccinulum* in Lower Miocene from Madura.

[2] DUYFJES (1938 b, p. 29) mentions *Cycloclypeus guembelianus* BRADY, and *Alveolinella quoyi* from sheet 121 (Baliga). The *Cycloclypeus* has 3 to 4 nepionic spirals. According to TAN SIN HOK (1932) such *Cycl.* species lived from the Upper Miocene to recent, being decidedly in a more advanced stage of evolution than the *Cycloclypeus eidae* TAN, found in the Rembang Beds.