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The Geology and the Origin of the Kataragama Complex of Sri Lanka

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Abstract: Recent geological studies carried out on the Kataragama Complex of the Southeast of Sri Lanka show that it was emplaced as a result of a Proterozoic collisional tectonic phase prominent in the Badulla area. Highland Group rocks were overthrust in this region on to the eastern Vijayan and were subsequently eroded so as to isolate the Kataragama Complex within the eastern Vijayan.

1. Introduction

The geology and the origin of the Kataragama Complex present some interesting problems to the study of the geology of Sri Lanka. Its position and geology in relation to the major rock groups of Sri Lanka remain enigmatic and a detailed study of the Kataragama Complex would undoubtedly contribute towards a better understanding of the geological origin of the major rock groups of Sri Lanka.

Cooray[3] proposed that a retrogressive metamorphism of the Highland Group* produced the Vijayan Complex* and that the Kataragama Complex now represents a metamorphic relict that had escaped the retrogressive process. Katz[8] on the other hand suggested that a difference in the bulk composition between the Highland and Vijayan rocks could be the reason for the resistance shown by the Kataragama rocks to the regional granulite facies metamorphism.

Recent ground water investigations in the Hambantota District have revealed some useful structural and lithological features that are worthy of record in working out a model for the origin of the Kataragama Complex. It is the aim of this paper to present the new information and introduce a working model to explain the relationship of the Kataragama Complex with the Highland and Vijayan rocks.

*In the early literature these were termed Highland Series and Vijayan Series.

2. General Geology

Figure 1 illustrates the location of the Kataragama Complex in relation to the main geological divisions of Sri Lanka. The Highland Group of rocks consist of a suite of metasedimentary and meta-igneous rocks formed under granulite facies conditions, quartzites, marbles, quartzo-feldspathic gneisses, charnockites and metapelites being the major constituents.

The metavolcanics of the Highland Group are hypersthene bearing rocks (eg. hypersthene-plagioclase-quartz ± microperthite ± diopside ± hornblende — garnet ± biotite) and are commonly known as basic, intermediate or acid charnockites. These rocks are intimately associated with the metasediments with their S-planes parallel[4] indicating their existence among the metasediments prior to deformation and metamorphism. Charnockites of a later generation occur as intrusives in the Southwest Group. The work of Wickremasinghe[14], Jayawardena and Carswell[7], suggests a calc-alkaline basaltic affinity for the charnockites of the Highland Group. On a further analysis of the chemistry of the rocks it has been suggested[12,13] that these charnockites are probably high-grade, metamorphosed bassalts that erupted contemporaneously with sedimentation in the Highland basin during the Archean. Amphibolites of the Highland Group show a close similarity to the charnockites.

A region known as the Sinharajah Basic Zone composed of basic charnockites and amphibolites occur in the northern part of the Southwest Group (Figure 1) and is marked by a magnetic anomaly in the area[5,8] described a pressure zoning around this body caused during a metamorphism with the lowest pressure adjacent to the body and suggested that it could be a large basic body that intruded the Southwest Group sediments.

A few small post kinematic granite bodies are present within the Highland Group at Ambagaspitiya, Arangala, Beruwala, Balangoda and Moragahakanda. These are coarse grained and contain large crystals of zircon.[3] Sheets of pink granites occur around migmatite complexes within the cores of large synorms in the Kandy District. These sheets appear to be synkinematic anatectic granites associated with the migmatisation in the folds[11,13] probably connected with the basement mobilization in the Vijayan Complex.

The Vijayan Complex consists of two detached parts termed the Western Vijayan and the Eastern Vijayan (Figure 1.) The Western Vijayan consists of basement type leucocratic biotite gneisses, migmatites, pink granitic gneisses and granitoids with compositions varying from granitic, syentitic to granodioritic. The granitoids frequently have enclaves of amphibolite and hornblende gneisses.[3] Small bodies of metasediments though present are rare.

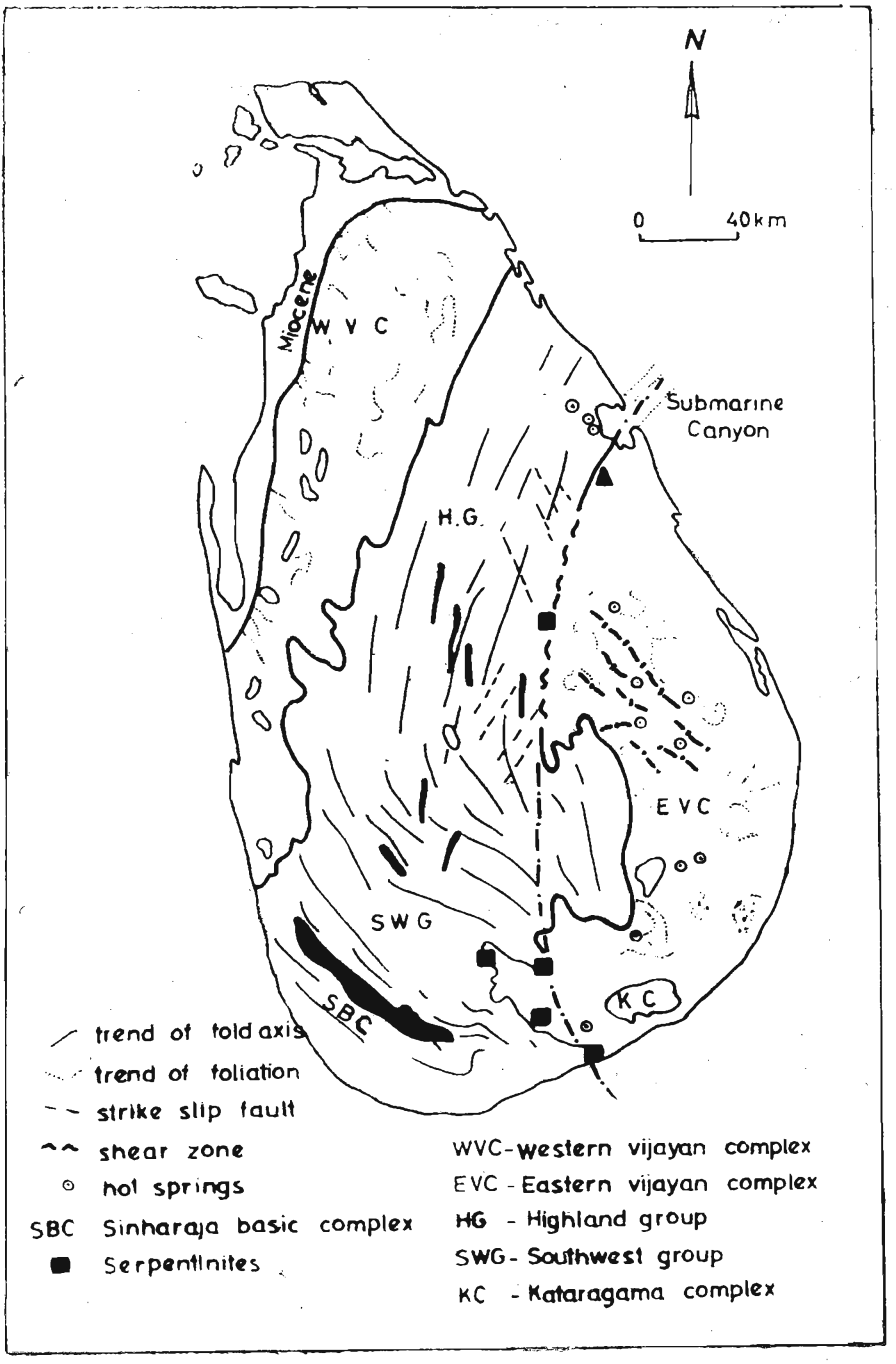

Figure 1. Major lithological divisions of Sri Lanka.

The Eastern Vijayan is composed of biotite/hornblende gneisses, granitic gneisses and scattered bands of metasediments and charnockitic gneisses. Small plutons of granites and acid charnockites also occur closer to the east coast.[3,7] A prominent feature in the area is the northwest trending suite of dolerite dykes. The dykes are extensively developed in the Maha Oya area and have been recognized as quartzo-dolerites. A line of hot springs extending from north to south marks a belt of high heat flow (Figure 1).

The Southwest Group occupying the Southwest corner of the belt exhibits calciphyres in place of marbles in the north, quartzites being poorly developed. The common types of metapelites are garnet sillimanite/graphite gneisses and schists. Towards the south, the replacement of the garnet by cordierite is conspicuous, although this feature is common to the whole of the Highland Group.[2] If well developed, a progressive replacement of garnet by cordierite is seen as cordierite - K feldspar symplectites around garnet, a feature interpreted by Hapuachchi as the result of an overprint of low pressure metamorphism within the granulite facies.

3. The Kataragama Complex

The Kataragama Complex consists of metamorphic rocks that are similar to those of the Highland Group (Figure 2). The main constituents are garnetiferous charnockites ranging from acid to intermediate, granulites with or without garnets, calc gneisses and crystalline limestones. Also associated in a small scale are quartzite bands, pegmatites and hornblende gneisses. This sequence of rock is geographically separated from the Highland Group proper and is surrounded by rocks of the Vijayan Complex.

3.1 Garnetiferous charnockites

The texture and the composition of these charnockites are highly variable. The study of a number of charnockite outcrops indicate that banding is a probable cause for the observed textural variations. In most cases the banding can be observed by their colour variations, the dark bands generally consisting of several inner bands of similar colour but varying texture and mineralogy. These are composed mainly of granulites, quartzites and amphibolites.

3.2 Granulites with or without garnets

These rocks are found as continuous folded bands and in the SW of the area studied (Figure 2) they occur as straight bands which gradually disappear in a NE direction. In most cases in this rock type, elongated parallel quartz lenticles with feldspars are present. Garnet is the only ferromagnesian mineral found and these lie parallel to the long axis of the quartz lenticles. In some cases, the granulitic texture is absent and in a few others garnets are not seen.

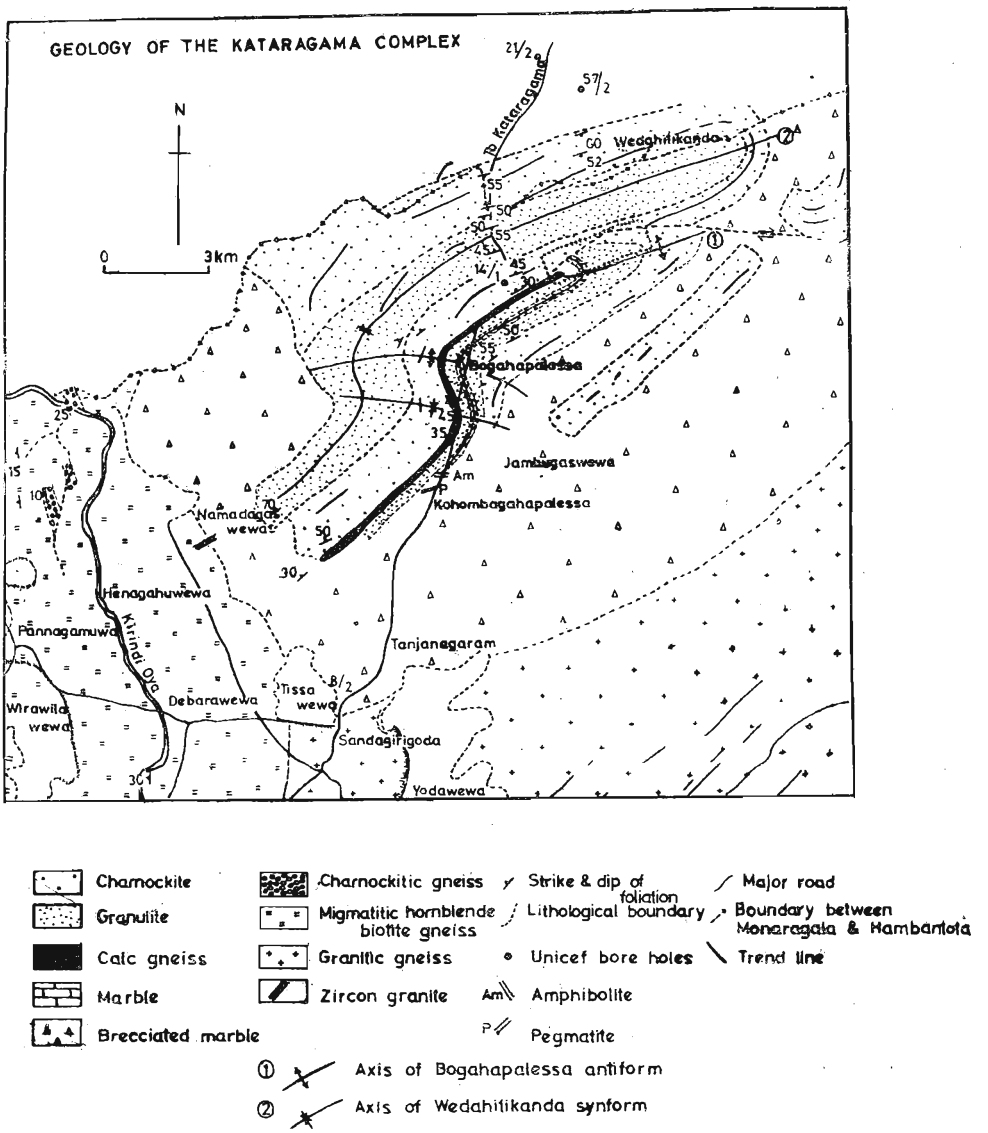

Figure 2. Geological map of the Kataragama Complex.

3.3 Calc gnesisses

These are found mainly in the central region of the synform and comprise of calc silicates, quartz, feldspar and very little free calcite. In fresh outcrops the rock is medium to coarse grained and appear gray or dark in colour. Phlogopite is found in abundance.

3.4 Crystalline limestones

An impure marble forms the boundary zone of the Kataragama Complex, and is exposed in a large area around the complex. In almost all parts, the impurity is caused by the inclusions of fragments from the surrounding rocks. These rock fragments vary in size and in some cases are as large as 100 sq ft (loc. 82). The inclusions are commonly angular and are composed of charnockites and hornblende biotite gneisses.

The study of this extensive area covered by these marbles indicates the complexity of the foliation trend (eg. between 6-7 mile posts along the Tissa-Kataragama Road). The marble found in some places show evidence of deformation as seen along the Kirindi Oya, near the Elagalle anicut. It is very clear that the calc gneisses and the impure marbles occupy the contact zone of the Kataragama Complex and that these contact rocks are highly brecciated. A 200' thick undisturbed marble layer of uniform thickness found in the Wedahitikanda antiform among the other metasediments forms an interesting feature.

3.5 Augen gneisses

A gneiss with feldspar augens of varying size (1-10 cm) is exposed at a quarry in Galpellessa and is located at the contact zone of the complex. This indicates recrystallization at a shear zone in the vicinity of the contact zone.

4. Structure

The rocks of the Kataragama area are folded into a tight synform (Wedahitikanda Synform) and an antiform (Bogahapalessa antiform) overturned towards SE (Figure 2). There is evidence for a secondary folding in the Bogahapalessa area and indirect evidence for overthrusting NE of the Bogahapalessa. The northern limbs of the overturned Bogahapallessa antiform are truncated by the southern limb of the Wedahitikanda Synform and associated with the thrusting is an east trending face of a dextral shear fault.

The Vijayan gneisses around the Kataragama rocks, dip towards the Complex (See also Kataragama Sheet, Advanced copy 1969, Geological Survey Department) indicating a stratigraphically higher position for the Kataragama rocks. This feature was not observed in the southwest quadrant of the Complex. Here the Kataragama rock trends are truncated by the Vijayan trends indicating a major structural discontinuity.

Diamond core drilling near the boundary and within the Kataragama Complex area have shown the higher stratigraphic position of the Kataragama rocks with respect to the Vijayan gneisses. Unfortunately critical depth has not been attained but the drill cores of wells 8/2, 12/2, 13/2 and 21/2 (Water Resources Board) exemplify the relative position of the Kataragama Complex and the surrounding Vijayan rocks.

5. A Model for the origin of the Kataragama Complex

The deformation which gave rise to the major structures in the Highland Group are considered to be the result of a collisional tectonic phase that occurred in the late Proterozoic.[9,10] This deformation overturned most of the major folds in the eastern part of the Highland Group and probably produced recumbent structures.

Hatherton *et al.*[6] using the Bouger anomaly patterns in Sri Lanka suggested an overthrusting of the Highland Group rocks in the Badulla area, towards the South east of the island. The lithological distribution and the drill hole data could be used to produce a generalized vertical section of the Kataragama Complex (Figure 3). This section provides a close analogy with the sections observed in overthrust sheets in granitic rocks in other parts of the world.[1] The impure marble at the base of the Kataragama rocks appears to have acted as a low-friction layer in the subhorizontal movement of the overthrust sheet.

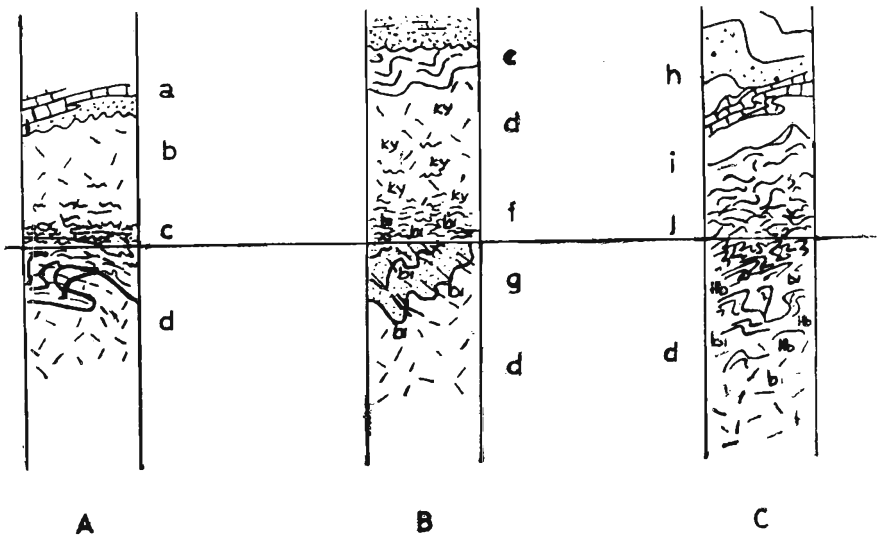

Figure 3. Generalized vertical sections of overthrust sheets developed in granitic rocks (Armstrong and Dick) compared with the vertical section of the Kataragama Complex A – Austroalpine Altkrystalline, B –Blue ridge, U.S.A., C – Kataragama Complex, Sri Lanka. a – Palaeozoic and Mesozoic sediments. Upper Palaeozoic crystalline basement diapthosized schist, gneiss, mylonite, d – recrystallized rocks, older Precambrian gneises, e – late Precambrian sedimentary and volcanic rocks, f – lineated mylonitized crystalline rocks, g – , low grade metamorphosed Precambrian sedimentary and volcanic rocks, h – high grade metasediments and metaigneous rocks, i - brecciated and intensely deformed marble.

6. Conclusions

We propose that the Kataragama Complex was emplaced in the eastern Vijayan by an overthrusting in the Badulla area and brought about during a collisional tectonic phase. Subsequent erosion of the thrust sheet isolated the Kataragama rocks in the Southeast of Sri Lanka (Figure 4).

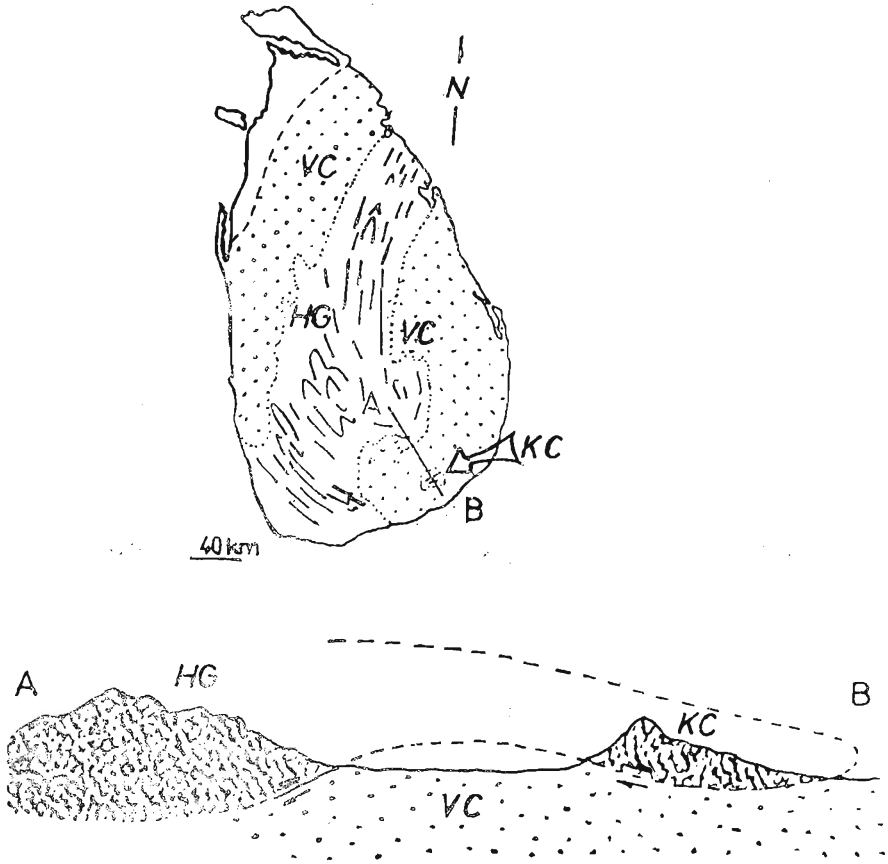

Figure 4. Emplacement of the Kataragama Complex (KC) by overthrusting of Highland Group (HG) rocks over the cross-section- Highland Group rocks, dotted area - Vijayan Complex.

Note: Recent field work in the north western part of Kataragama Complex by one of the authors (T. Munasinghe) confirmed the tectonic nature of the Kataragama Complex — Vijayan boundary. The core trench excavation (extending for more than 5 km) of the Kisiudi Oya dam exposes a perpendicular section across the major lithological boundary. Thus the occurrance thrust faults, overturned folds (with their planes dipping west), mylonite and tectonic breccia, attest to the presence of a large-scale low angle thrusting towards east.

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