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THE FIELD RELATIONSHIPS, AGE, PETROGRAPHY AND GEOCHEMISTRY OF THE CRETACEOUS ETENDEKA VOLCANICS AND THEIR RELATIONSHIP TO CONTINENTAL RIFTING

Progress Report for 1982/1983

by

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1. RESULTS

Integration of the field, petrographic and chemical data we have obtained has made it possible to describe in greater detail the diversity, distribution and compositional characteristics of the Etendeka volcanics from north-western South West Africa/Namibia and this is conveniently done under the following headings:

1.1 Classification and General Description

The classification we have adopted for the samples previously analysed by quantitative X-ray fluorescence is shown in Fig. 1 where it may be seen that the two elements K_2O and SiO_2 conveniently separate the rock types, we have encountered. Included within the basaltic rock field are the Tafelberg and Albin lavas and dolerites, together with the Horingbaai and regional dolerites. The fields outlined in Fig. 1 have been transferred to Fig. 2 in which the data we have obtained during the past year have been plotted according to rock type.

It is immediately apparent that for the more basic rock types < 53 per cent SiO_2) there is reasonable correspondence in the disposition of the points in Figs. 1 and 2, and detailed examination shows no real differences in chemistry and mineralogy for the various basic rock types mentioned above. However, even allowing for the semi-quantitative nature of the slab data (Fig. 2), it seems clear that the evolved basic rocks (> 53 per cent SiO_2) extend to higher SiO_2 levels than previously encountered. These rocks, mostly from the coastal region, include representatives both of the Tafelberg and Albin magma types. In the former case the evolved basalts are texturally and mineralogically similar to those previously encountered in the Tafelberg region except that those with high SiO_2 (60 per cent) have a higher proportion of plagioclase to pyroxene coupled with more well developed interstitial textures and/or a more glassy groundmass. The SiO_2-rich Albin basalts are chemically much more evolved than Albin rocks previously analysed. Mineralogically they are similar to the plagioclase phyric lavas from the Albin type area, but are much less altered.

They contain dominant plagioclase and lesser amounts of augite and pigeonite phenocrysts, together with interstitial textures and brown devitrified glass similar to the Tafelberg types.

Of the 19 evolved basalts shown in Fig. 2, 13 are of the Tafelberg type and are from widely differing localities, mainly from the coastal region north and south of the Koigab River, but extending up to Terrace Bay, and including one sample from as far south as the Albin type locality. The six evolved Albin basalts - a new feature of our collection include samples from north of Terrace Bay, north of the Huab River and one sample from north of the Koigab River.

With regard to the acid lavas, Fig. 1 indicates that we have previously adopted the names quartz latite and high-K dacite for these rocks, although collectively it is simpler to refer to both types as quartz latites. The quartz latites shown in Fig. 2, all from the coastal region of the Etendeka, show a fair scatter of data points,

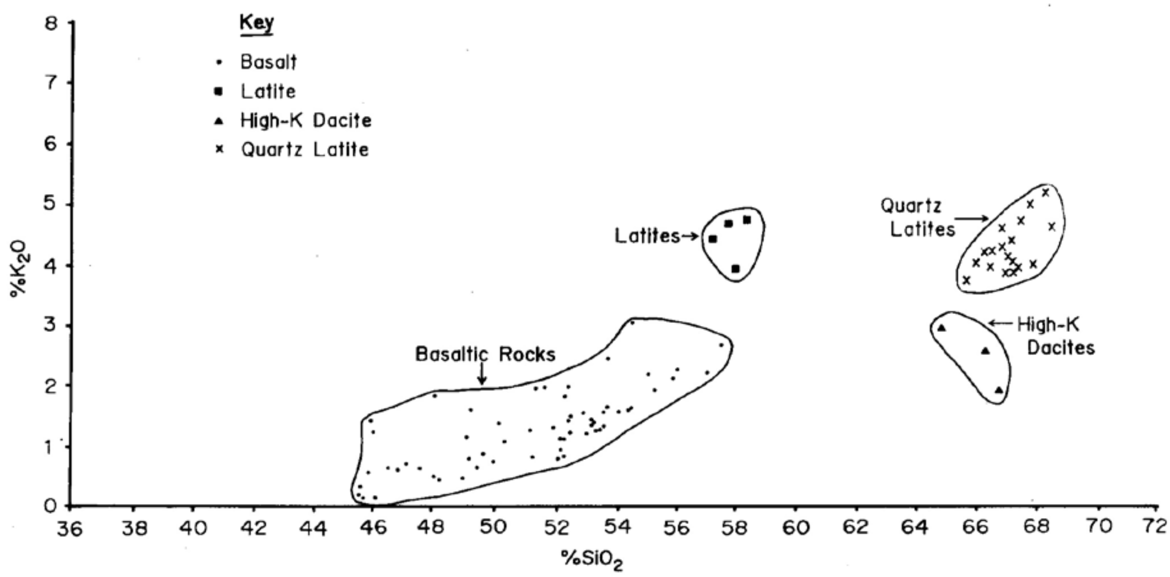

Fig. 1: Etendeka powder run.

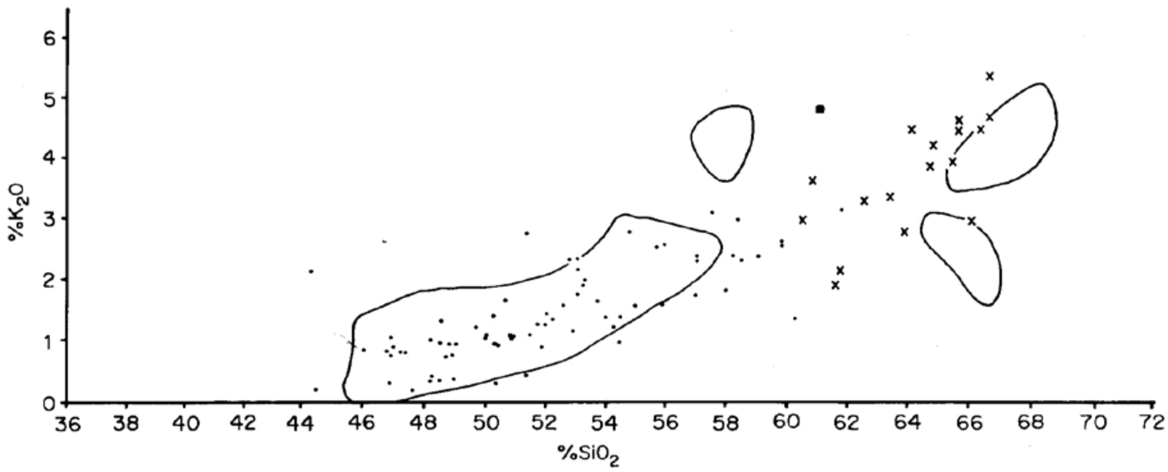

Fig. 2: Etendeka slab run, KLS 221—304.

but even allowing for anaytical error it seems clear that their SiO_2 contents extend to lower levels when compared to the quartz latites in Fig. 1, which are mostly from the Tafelberg locality. In fact if these results are confirmed then the implied continuum of SiO_2 concentrations might necessitate a re-evaluation of the conclusions presented in Appendix A.

The two interbedded quartz latite units first recognized at Tafelberg can easily be distinguished petrographically since the upper unit is aphyric while the lower unit is plagioclase phyric. Further south, but still on the eastern region of the lava field, plagioclase is joined by augite, pigeonite and hypersthene as phenocryst phases - the latter is typically present in the varieties shown in Fig. 1 as high-K dacites (it follows that these dacitic rocks are not present in the upper quartz latite unit). The quartz latites from the coastal region (Fig. 2), are predominantly of the lower quartz latite unit type with both phenocrystic varieties (i.e. plagioclase only or plagioclase plus pyroxenes) being present, together with two hypersthene bearing dacitic types. Two samples are, however, mostly aphyric and more similar to the upper quartz latite unit at Tafelberg. In view of faulting in the coastal area coupled with the easterly dip of the lava succession in this region it does not seem possible to correlate the coastal quartz latites with those at Tafelberg, but this aspect will receive detailed attention in the coming year.

1.2 Distribution of Rock Types

We now have sufficient samples characterized that we can begin to assess the regional distribution of the various rock types found in the Etendeka province. Since this study is concerned with the association between volcanism and rifting it is also appropriate to comment on the volcanics found in the previously adjoining Parana province in Brazil. Data from the literature for the

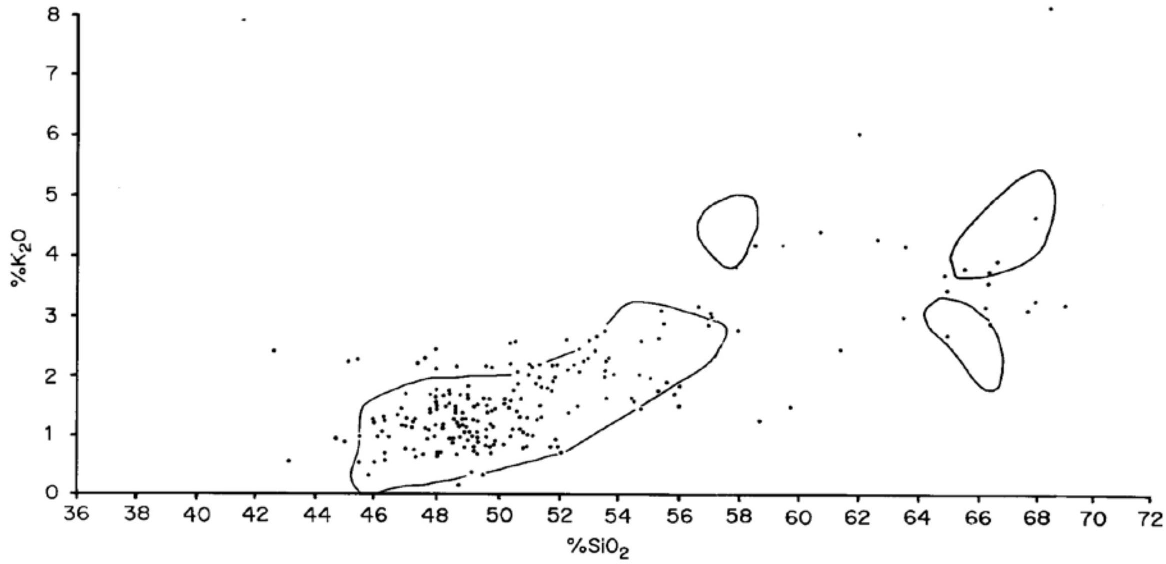

Fig. 3: Paranà Basin, Brazil.

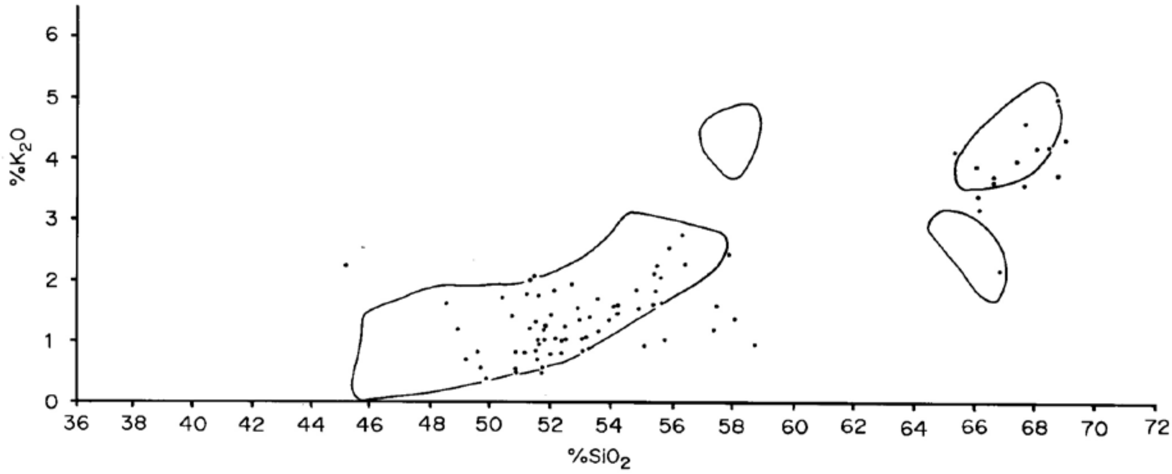

Fig. 4: Southern Paranà Basin, Brazil.

Parana volcanics and plotted in Figs. 3 and 4, and can be directly compared with the range of compositions shown in Fig. 1.

Returning to the Etendeka volcanics, a simple three-fold classification showing the distribution of rock types is depicted. The new chemical and petrographic data confirm that the Horingbaai intrusives are found only at the Albin type locality and that the Albin basalts themselves are confined to the coastal regions. Whether the latter occur between the coastal region and Tafelberg remains to be demonstrated, but current stratigraphic relationships suggest that this is unlikely.

The important observation that has emerged from our work over the past year is the demonstration of both the greater volume and wider distribution of the quartz latites and, to a lesser extent the evolved basalts, than hitherto suspected. For example the presence of a quartz latite in the Albin section and in lavas surrounding Messum was not suspected (it should be noted that the altered and fine-grained nature of the volcanics makes it very difficult to distinguish the quartz latites from the evolved basalts in the field!). Although our field work did suggest that many of the samples north and south of the Koigab River were quartz latites and evolved basalts, these flows may be more laterally persistent than previously believed. This aspect will be intensively investigated during the following year.

The evidence suggests that the quartz latites are more widespread then previously thought. If this observation is coupled with the known presence of quartz latites in the Parana volcanics in Brazil (Figs. 3 and 4) and their widespread occurrence in the juxtaposed Brazilian coastal region, then their previous pre-drift geographical coverage must have been very extensive. The important observation arising from this relates to the heat required to produce these rocks, since it is indicated that the quartz latites are crustal melts. If this heat is ultimately of mantle derivation, it follows that enormous volumes of basaltic lavas are required to melt the crust in such volume and/or that the Etendeka (and Parana)

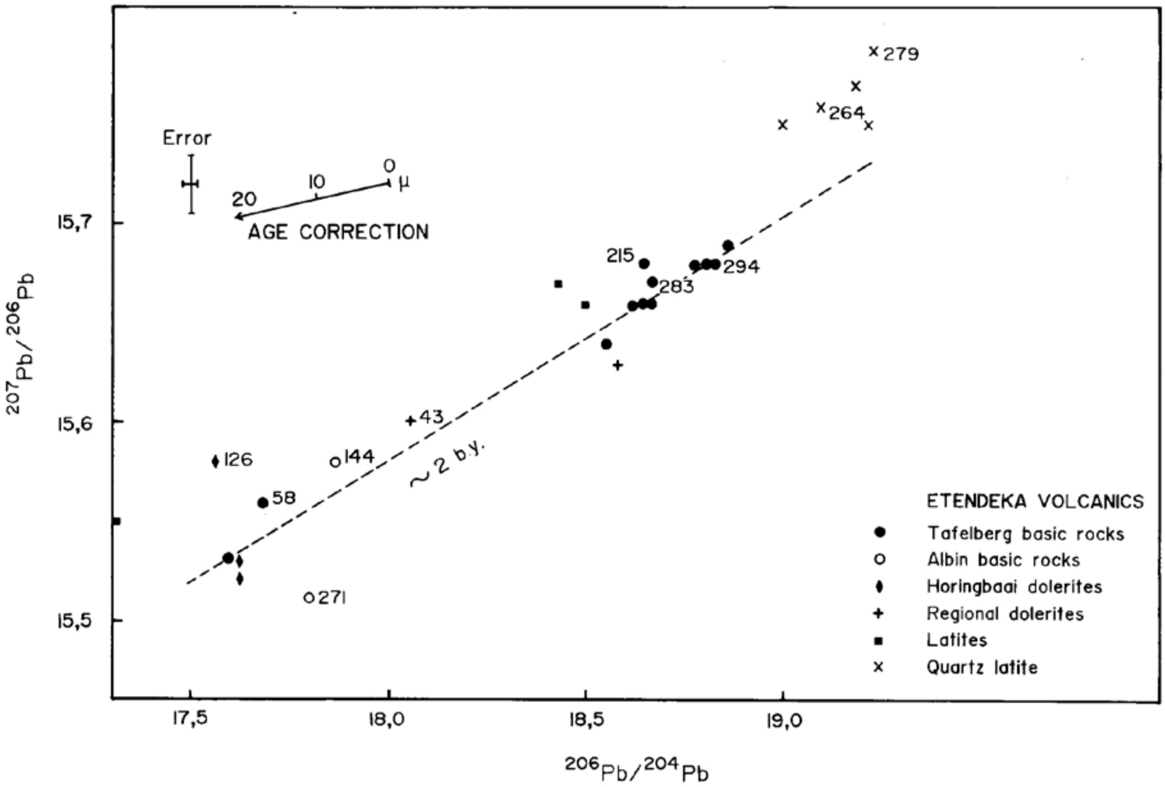

Fig. 5: Pb-isotope results.

volcanics were sited over a distinct thermal anomaly (plume ?) in the underlying upper mantle. In view of the enriched geochemical source area characteristics of the basalts this anomaly would also be a geochemical anomaly. It may also be speculated that since present isotopic data suggest that the quartz latites are melts of Damaran rocks it is not inconceivable that the melting processes were such as to produce local concentrations of economically important metals in the quartz latites, although no such indications are yet apparent.

Finally it should be noted that the latites shown in Figs. 1 and 2 are still found only in the Tafelberg region. We shall continue to attempt to identify the extent of these rocks and their relationship, if any, to the other Etendeka volcanics.

1.3 Pb-isotopes

Measurement of Pb-isotopic ratios in volcanic rocks provides a powerful tool for investigating whether different rock types are related or not, whether crustal contamination has taken place or not, and for inferring source area characteristics and evolutionary history. During the past year one of us (P.J. Betton) has had the opportunity of making 10 new Pb-isotopic measurements at the Department of Earth Science at the University of Leeds and the results obtained are shown in Fig. 5 together with our previous data (the new data are indicated by appropriate sample number designations). In general, the new data confirm the trends previously obtained. Thus the quartz latites are confirmed as the most radiogenic samples and they do not appear to be related to the basaltic rocks, a conclusion reached by our previous work. Similarly, the Horingbaai dole rites as a group still constitute the least radiogenic of our samples. In detail we note that the new data slightly extend the range of isotopic compositions shown by the lavas, as demonstrated by samples 58, 144 and 271, and also for the regional dolerites (sample 43). The 2.0 b.y. reference line can be interpreted, on the basis of Pb-isotopic arguments alone, either as a mixing line involving old continental crust or as an indication of a mixed heterogeneous mantle source. In either case the reference line mayor may not have age significance. However, the Pb-isotopic evidence needs further evaluation in conjunction with other evidence because the Pb-isotopic data do not show the expected positive correlation with the Sr- and Nd-isotopic data for several samples where all three isotopic systems have been measured. Thus sample 58 in Fig. 5, one of our least evolved Tafelberg lavas, is relatively unradiogenic, in contrast to its very high $^{87}Sr/^{86}Sr$ initial ratio (0.712).