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Report on site visit to potential meteorite impact site near Kangnas

I was contacted by Aurecon to visit two possible meteorite impact craters near the farm 'Kangnas'. This investigation formed part of an environmental impact study of potential site for a wind. I visited the area on April 2nd 2012 with UCT Geology MSc student Mr Louis Smit. The farmer, Mr van Niekerk, was extremely helpful and provided us with a guide to show us the 2 localities. Mr van Niekerk told us that he was of the opinion that the large crater was of volcanic origin, being the surface expression of a kimberlite pipe.

We were taken to two possible crater localities; a small crater at S29.57284 E18.46905, and a larger crater at S29.67098 E18.4639. The small crater showed little evidence of being a crater and is probably a depression where a thicker than normal sequence of calcrete developed. It will not be discussed further in this report. By contrast, the large crater consisted of a distinct depression about 1 km in diameter and it is therefore possible that it is a crater..

Unfortunately, the whole area has no exposures of bedrock, being covered by 10 m of calcrete. This meant that it was not possible to examine the bedrock that would have been the 'target' were this to be a meteorite impact crater. According to Mr van Nieker, the calcrete is typically about 10 m thick in the area, but is at least 80 m thick in the large crater. We took numerous samples of calcrete and silcrete as well as 6 samples of bedrock that were lying loose on the surface.

Previous work

The part of the 1:250 000 Pofadder geological map with the Kangnas area (Agenbacht, 2007) is shown in Figure 1. The black diamonds on the E side of the map are Cretaceous olivine melititite pipes. These pipes are common in Namaqualand to the E of Kangnas, but the large crater near Kangnas has not been mapped at an olivine melilitite. The pipes identified on the Pofadder map were described by Agenbacht (2007) as follows: '*The plugs are pipe-like in shape and some have conical craters infilled by later sediments. They typically occur as black to dark-brown-weathering rubble-strewn mounds, low hills, or merely a collection of* *boulders scattered over the surface of a calcrete covered pan*.' The large crater at Kangnas was considered by de Wit et al. (1993) to be '*a late Cretaceous/early Teriary alkaline plug*'. One of the 6 rock samples collected in the area was a piece of olivine melilitite (confirmed by thin section examination; Fig. 3). However, there is no evidence that this 10 cm diameter piece of rock originated from the large crater. It could easily have been transported from one of the olivine melilitites to the east of Kangnas.

Examination of samples collected

Thin sections were made of 6 of the samples collected and examined under a petrographic microscope. The two samples of gneiss examined showed no evidence for deformation (e.g. planar deformation features) that might be caused by the impact of a meteorite. Such features would be expected in the target rocks of an impact site the size of the Kalkkom 'crater'. On the other hand, the thin sections of calcrete were found not to contain any minerals that might have originated from olivine melilitite. Furthermore, the samples of gravel collected did not contain any minerals associated with olivine melilitite (or kimberlite).

Discussion

It seems likely that the Kalkkom 'crater' was formed by the eruption of an olivine melilitie pipe about 55 Ma (million years ago). This is the opinion of de Wit (1993) and is consistent with the presence of numerous olivine melilitite pipes in Namaqualand. A series of such pipes is found about 10 – 30 km to the east of Kalkkkom. It is much less likely that the crater was the result of a kimberlite pipe. These are found north of the Orange River and Kalkkom is situated over 50 km from the area where kimberlites are found.

However, there is no physical evidence to prove that the Kalkkom Crater is an olivine melilitite pipe. Neither the geological map nor de Wit et al (1993) mention the presence of olivine melilitite in the immediate vicinity. There are numerous other explanations for the presence of a pan, for example related to structures in the underlying gneiss. The geological map (Fig. 1) indicates that Kalkkom is situated at or near a synform whose axis trends E-W. the 'crater' might therefore represent a pan developed at a depression where surface water was unable to drain away as a result of the underlying structure. One other possible explanation is the depression was caused by a meteorite impact. The Kalkkom Crater bears a superficial resemblance to the Kalkkop Crater in the Easter Cape (Fig. 5) which was shown to be the result of a meteorite impact about 250 000 years ago (Reimold et al., 1998). Although the crater shape at Kalkkop is more obvious than at Kalkkom, this may be due to a difference in age or rate of erosion. The meteorite origin of Kalkkop was only proved as a result of drilling, which intersected shocked brecciated material below the base of the calcrete in the centre of the crater (at > 90 m depth).

Conclusions

It is possible that the Kalkkom 'Crater' formed as a result of an olivine melilitite eruption but apart from the presence of olivine melilitite craters nearby, there is no convincing supporting evidence for such an origin.

A meteorite impact origin is possible but less likely. The absence of any exposed country rock means that it was not possible to identify shock-induced fractures.

It is possible that neither of the above mechanisms was responsible for the crater and that it is related to a depression formed in the synform in the underlying gneiss. The only way to distinguish between these possible origins would be to undertake drilling (preferable core drilling) in the centre of the crater through the calcrete into the underlying bedrock. This would be a scientific interest, but hardly seems justified in the context of this environmental impact study.

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References

Agenbacht, A.L.D. (2007). *The geology of the Pofadder area*. Explanation: Sheet 2918. Council for Geoscience, Pretoria.

Reimold, W.U., Koeberl, C. and Reddering, J.S.V. (1998). The 1992 drill core from the Kalkkop impact crater, Eastern Cape Province, South Africa: stratigraphy, petrography, geochemistry and age. *Journal of African Earth Sciences*, **26**, 573.592.

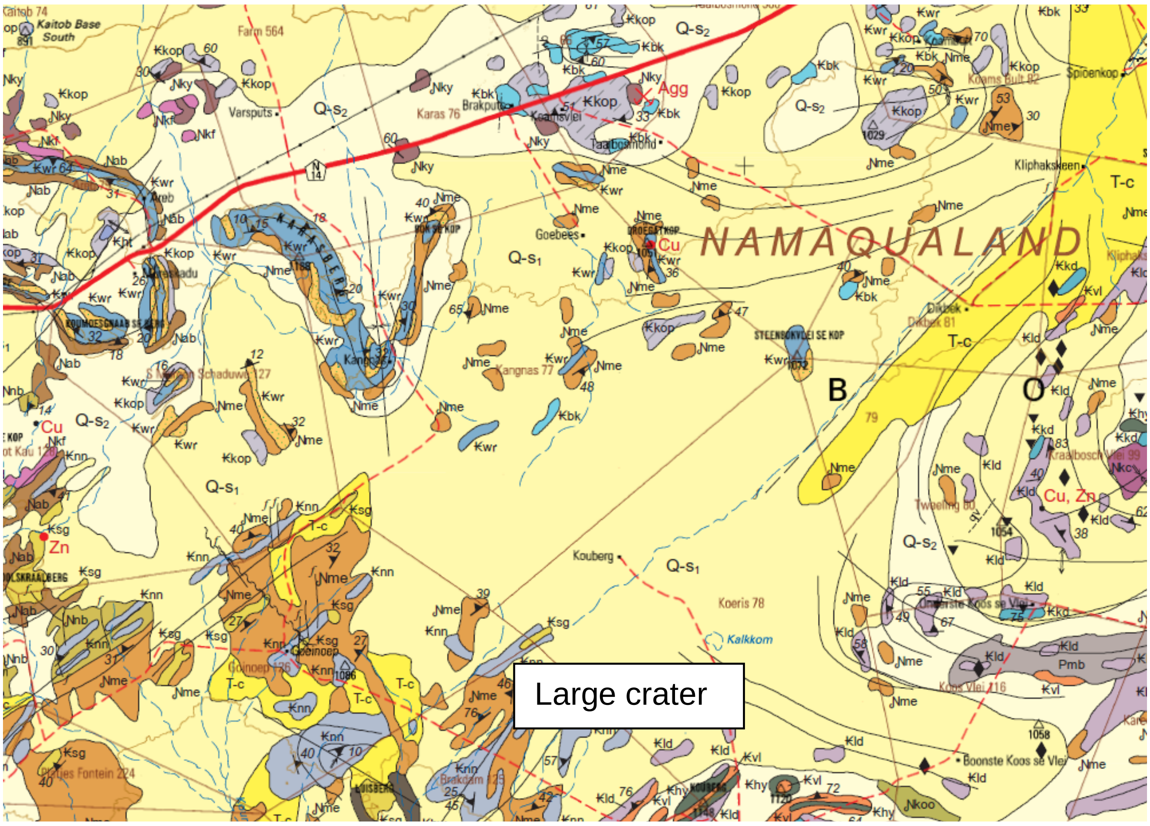


Figure 1. Portion of the 1:250 000 map of the area around Kangnas. The width of the map is approximately 20 km, The large crater is called Kalkkom on the map.

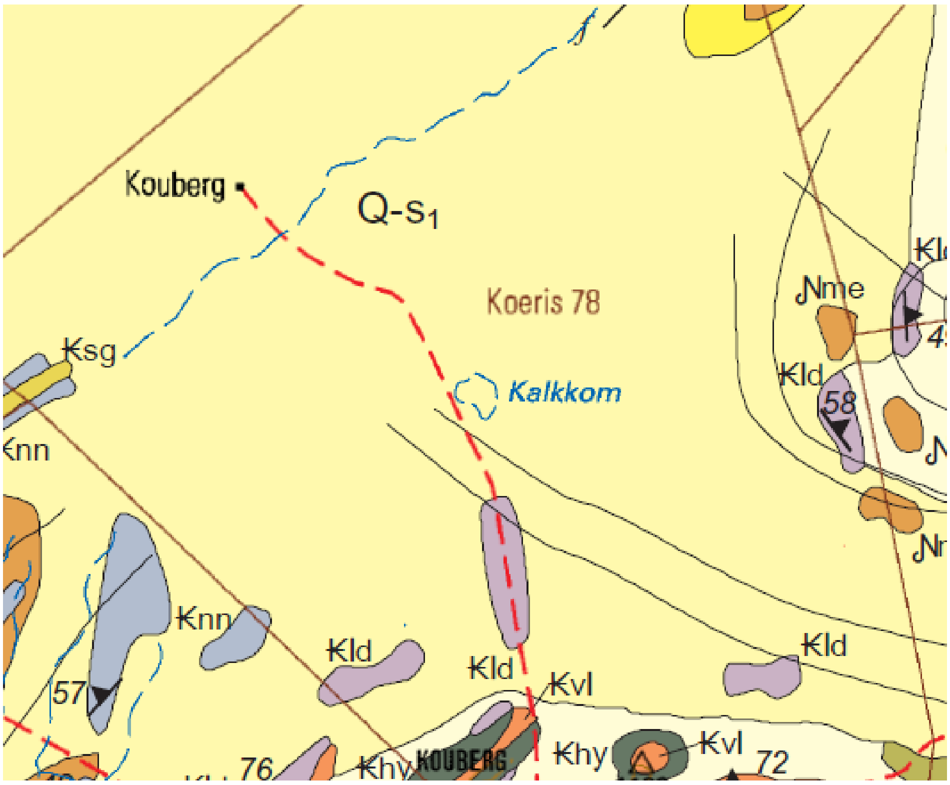
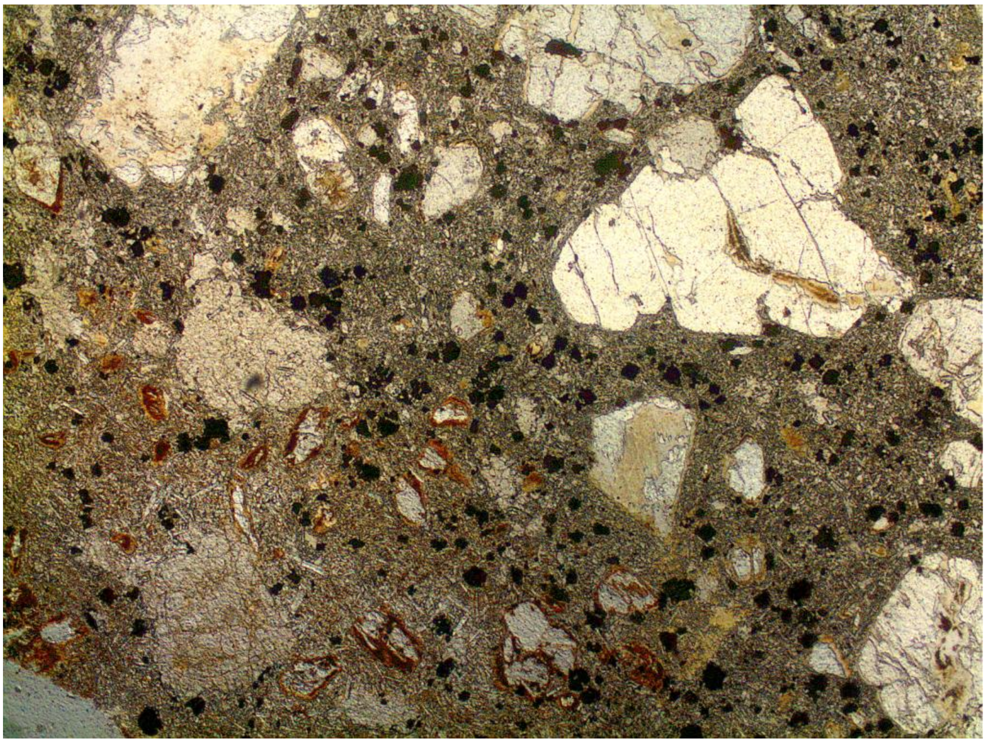


Figure 2. Detail of geological map of the area arounf the large crater ('Kalkkom'). Note that no olivine melilitite or kimberlite has been identified at Kalkkom.



Photomicrograph of sample AUR14 collected at S29.57284, E18.46905 in plane polarised light. This sample was a loose 10 cm diameter piece of rock. The large colourless crystals are olivine. The rock is an olivine melilitite. Field of view approx. 4 mm.

Figure 4. Google Earth image of the Kalkkom 'Crater' near Kangnas. The width of the image is about 2 km. Vaguely concentric rings of calcrete can be seen in the northern part of the crater.

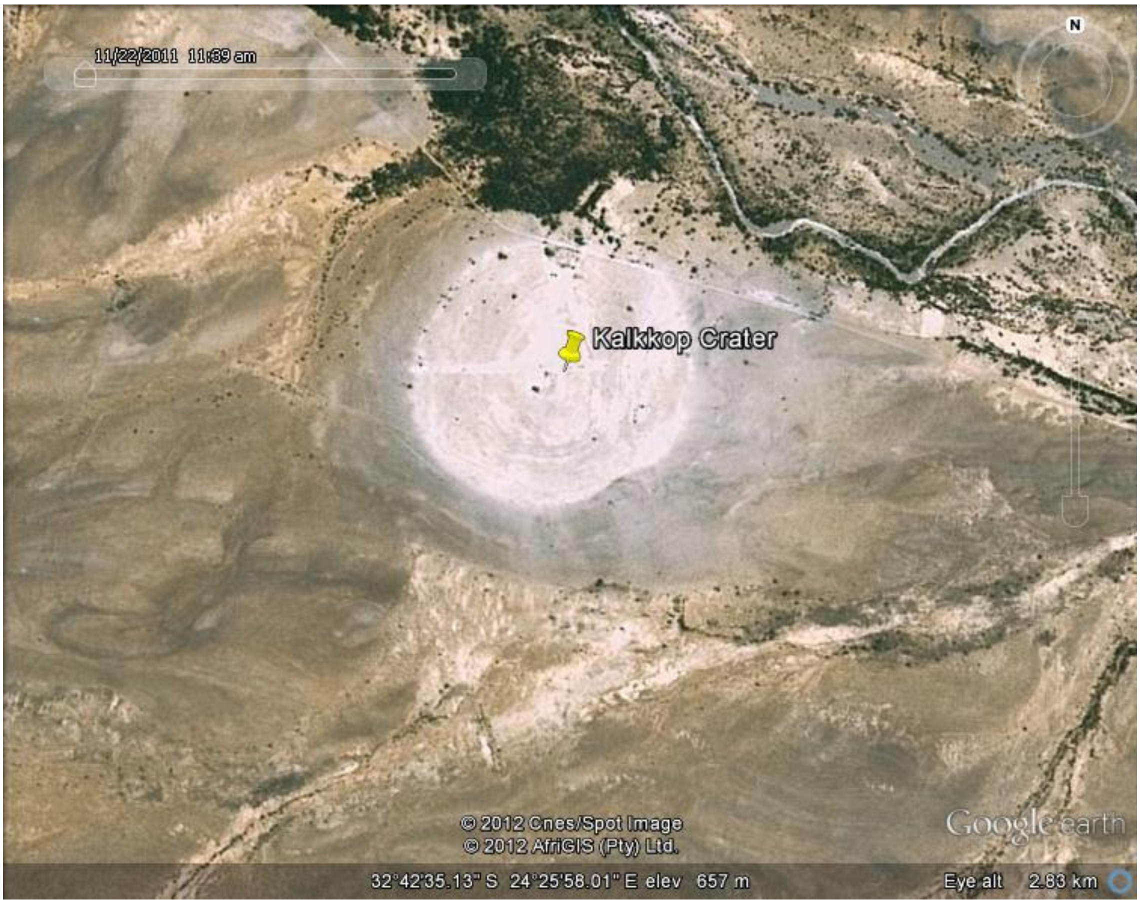


Figure 5. Google Earth image of the Kalkkop Crater 30 km south of Graaf Rienet. Drilling has shown that this crater was the result of a meteorite impact about 250 000 years ago

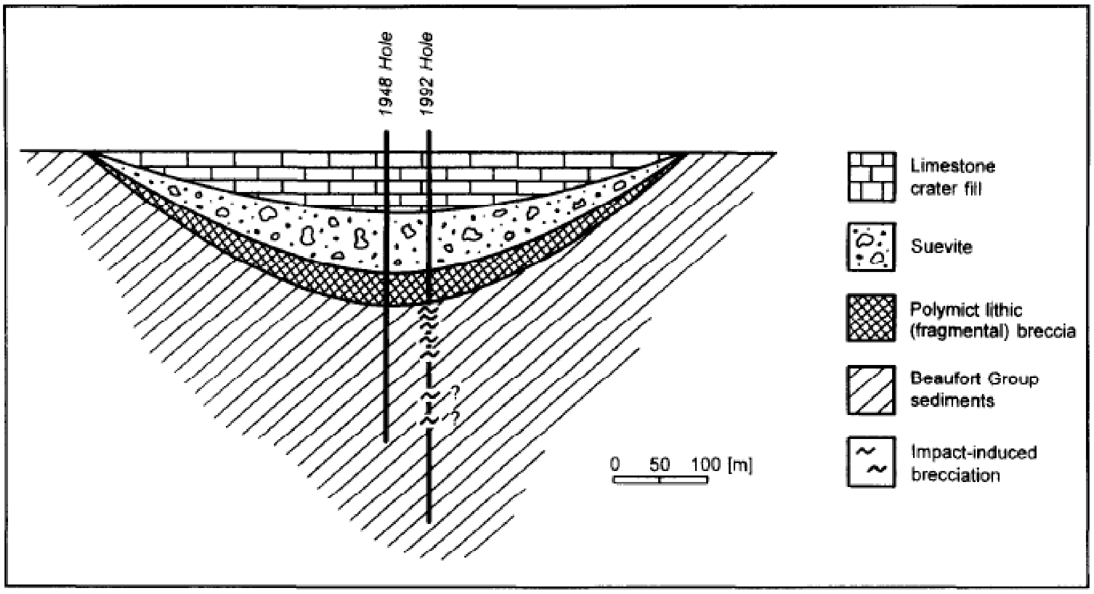


Figure 6. Cross section of the meteorite impact crater at Kalkkop showing the expected structure if Kalkkom (Kangnas) was of meteorite impact origin. From Riemold et al (1998).