ROTER KAMM IMPACT CRATER, SWA/NAMIBIA: NEW GEOCHEMICAL AND ISOTOPIC STUDIES AND FURTHER EVIDENCE FOR POST-IMPACT HYDROTHERMAL ACTIVITY. Christian Koeberl[1,2], Wolf Uwe Reimold[3], Janice Bishop[1,4], and Roy McG. Miller[5]. [1]*Institute of Geochemistry, University of Vienna, A-1010 Vienna, Austria.* [2]*Lunar and Planetary Institute, 3303 NASA Road One, Houston, TX 77058, USA.* [3]*Economic Geology Research Unit, University of the Witwatersrand, P.O. Wits, Johannesburg 2050, South Africa.* [4]*Department of Chemistry, Brown University, Providence, RI 02912, USA.* [5]*Geological Survey, P.O. Box 2168, Windhoek 9000, Namibia.*

INTRODUCTION. The Roter Kamm impact crater is situated at 27° 46'S and 16° 18'E in the Namib Desert in SWA/Namibia and has a rim-rim diameter of about 2.5 km. The impact nature of the near-circular structure was recently confirmed by the discovery of impact breccias containing shock metamorphosed clasts [1,2]. The impact occurred in Precambrian granitic-granodioritic orthogneisses of the 1200-900 Ma old Namaqualand Metamorphic Complex that are invaded by quartz- and quartz-feldspar-pegmatite intrusions and were probably overlain by Gariep metasediments. Dune sand now covers the slopes of the crater rim and completely fills the crater interior. Impact breccias are found along the crater rim [2], as well as unusual yellowish quartz pebbles. The mineralogy of these pebbles and the fluid inclusions therein (in comparison with quartz from pegmatite bedrock) was studied [3] and provided evidence for a post-impact phase of extensive hydrothermal activity, resulting from the kinetic energy of the impact.

SAMPLES AND ANALYSES. Reimold and Miller [2] recognized schist and pegmatite as major components for the formation of melt breccias. To improve the data base, we analyzed more than 20 target rocks and impactites (including pseudotachylite, impact breccias, and clasts within melt breccias) for major and about 30 trace elements. In addition, Rb-Sr isotope data for three rim granite samples and mineral separates thereof were obtained. All samples were collected at the crater rim. The samples URK-86A and -86C were found as 6-10 cm large clasts in schistose melt breccias. They consist of a core, which is composed of phlogopite-like mice with pyrite and quartz and several vol% chlorite, and a rim that is primarily composed of chlorite with variable amounts of light mica and pyrite. We interpret these inclusions as hydrothermal fillings of large vesicles.

RESULTS AND DISCUSSION. Contrary to the target geology of many other impact structures, there is a large number of different target rocks at Roter Kamm, which show a wide variation in major and trace element compositions. This has also been observed for impact melt breccias and pseudotachylites. Our analyses confirm that pegmatites and gneiss or schist have been a primary source for most of the melt breccias. The analyzed pseudotachylites probably formed from gneissic basement and/or quartz-feldspar-pegmatites, and pseudotachylite analyses showed further that fluid phases have not been important in reducing melting temperatures during their formation. Trace element data for samples from the Namaqualand Complex basement are shown in Fig. 1. Data for pegmatites and metasediments (not shown here) differ slightly, but show a similar range. Melt breccia data are given in Fig. 2. The melt breccias are rather heterogeneous with regard to trace element abundances (not patterns). No characteristic differences are obvious between quartzitic melt breccias (-68, -87A) and schistose breccias. REE patterns of the analyzed melt breccias (Fig. 3) are similar to each other. Sample -87A has lower REE concentrations, which is due to its quartz-rich nature. From the REE patterns we conclude that schistose and quartzitic melt breccias were derived from one stratigraphic unit of internally variable quartzite-schist proportions, but having a similar chemical signature. Clast sample -86A displays a REE pattern similar to those of the melt breccias. Results of the Rb-Sr isotopic study are shown in Fig. 4. Whole rock data were regressed to an age of 1498 Ma, and three data for sample URK-M (feldspar, whole rock, biotite) define an "age" of 466 Ma, which represents a Pan-African cooling age [2]. Unfortunately, the thermal events that affected the rim basement were not sufficient to pervasively reset the Sr-isotopic signatures of the basement granites and their mica and thus only metamorphic ages, probably related to the Damara orogenesis, were obtained.

CONCLUSIONS. Three compositional types of melt breccias have been established - the main group of schistose breccias, quartzitic breccias, and some breccias derived by mixing of metasediments and basement rocks. This study has provided additional support for the suggestion of a significant post-impact hydrothermal event [3]. The presence of large vesicles filled with hydrothermal mineral assemblages in schistose melt breccias, carbonate fillings of (cooling?) cracks in melt breccias, partial enrichment of melt breccia in mobile trace elements, and the similarity of trace element signatures of melt breccias and vesicle fillings are consistent with this suggestion. As hydrothermal alteration of basement rocks from the rim is not significant (no carbonate-rich hydrothermal deposits have been recognized in rim specimens), it is reasonable to associate the hydrothermal event identified in the quartz pebbles [3] and melt breccias with the immediate post-impact phase, when melt breccias could have been exposed to hot fluids generated by impact heating from mainly porous metasedimentary rocks.

GEOCHEMISTRY OF THE ROTER KAMM IMPACT CRATER: Koeberl C. et al.

References: [1] Miller R.McG. and Reimold W.U., Meteoritics 21 (1987) 456-458. [2] Reimold W.U., and Miller R.McG., Proc. 19th LPSC (1989) 711-732. [3] Koeberl C., Fredriksson K., Götzinger M. and Reimold W.U., GCA 53 (1989) 2113-2118.

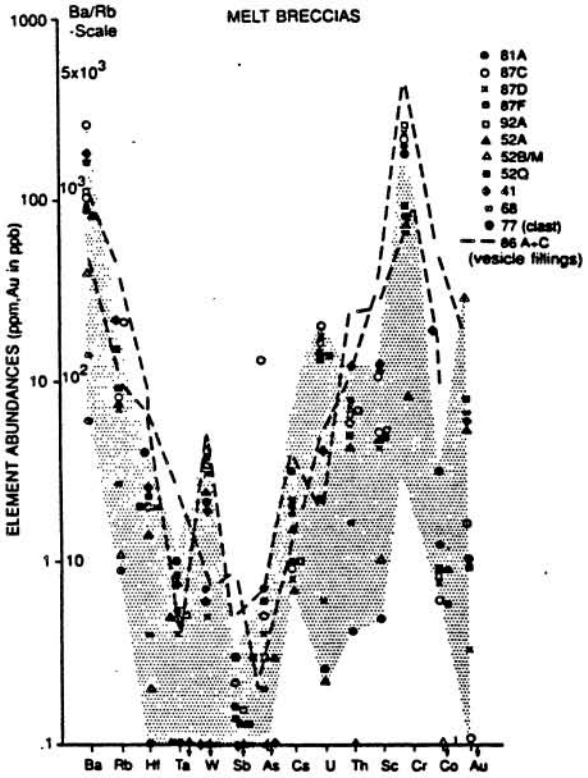

Fig. 1. Spider diagram for lithophile and siderophile elements in melt breccias of the Roter Kamm crater, including samples -86A+C (possible hydrothermal vesicle fillings).

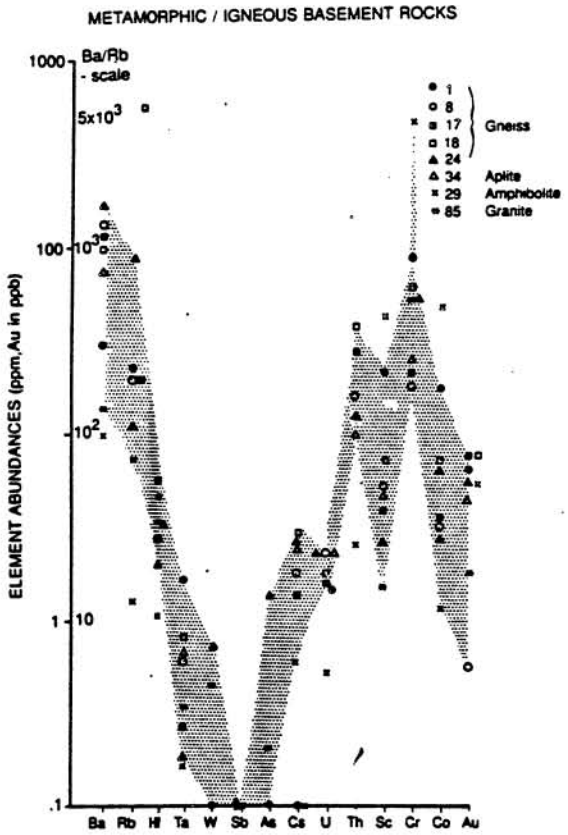

Fig. 2. Spider diagram for lithophile and siderophile elements in basement rocks of the Roter Kamm crater (including data from [2]).

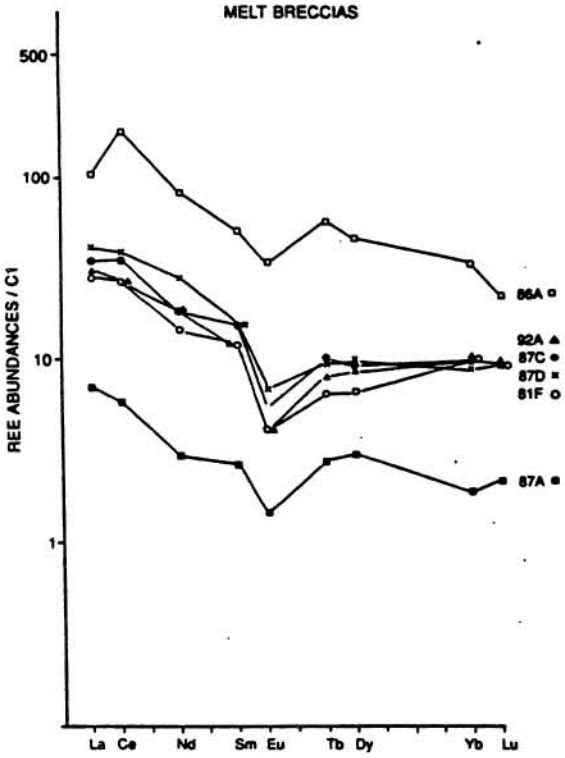

Fig. 3. REE patterns of Roter Kamm melt breccias

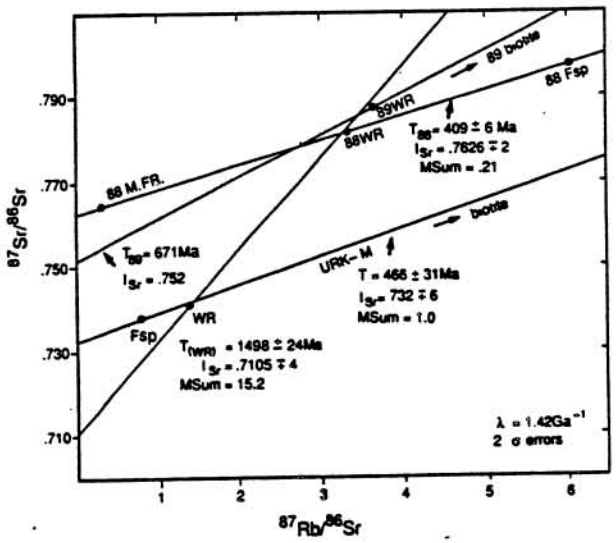

Fig. 4. Results of Rb-Sr isotope analyses of granitic basement samples URK-M, URK-88 and -89, and mineral separates thereof.