U–Pb-data for baddeleyite and zircon from the Foy offset dyke (Sudbury, Canada)

M. Ostermann
U. Schärer
D. Buhl
A. Deutsch

Univ. Paris 7 and IPG-Paris, 2 place Jussieu, F-75251 Paris Cedex 05, France
Inst. für Geologie, RU Bochum, D-44780, Bochum, Germany
Inst. für Planetologie, Univ. Münster, D-48149, Münster, Germany

The 1.850 Ga old Sudbury Structure, situated in the south-eastern part of the Canadian Shield, represents a deeply eroded multi-ring impact basin with a diameter of the original modified crater in the order of 200 to 280 km. Within the frame of these models, the so-called Sudbury 'Igneous' Complex (SIC) is interpreted as coherent impact melt sheet, produced by impact-melting of the pre-existing crust. At the base of the SIC, a heteroclastic melt breccia forms a discontinuous thin layer (Sublayer) (Brockmeyer, 1990; Lakomy, 1990; Grieve *et al.*, 1991; Stöffler *et al.*, 1994; Deutsch and Grieve, 1994; Roest and Pilkington, 1994). An extensive dyke system, the 'Offset Dykes' (Coleman, 1905), radiate outwards from the main mass of the (SIC) into the brecciated country rocks. According to (Grant and Bite, 1984), three different types of Offset Dykes are distinguished: (i) radial dykes, (ii) dykes occurring parallel and concentric to the Igneous Complex, and (iii) discontinuous melt pockets. The genetic relationship between SIC, the Sublayer and the Offset Dykes has been described in several models, although age relationships between these formations are not well established. The dominant lithology of the Offset Dykes, which are of prime importance for the geneses of the world-famous ore bodies, is quartz dioritic, with either hypersthene, clinopyroxene or amphibole as the dominant mafic mineral. Proximal to the SIC, the Offset Dykes contain various fragments of the Sublayer, and they always show sharp contacts with the country rocks.

To improve existing genetic models, four different samples from the Foy Offset Dyke, which is of type (I) and can be traced for up to 28 km into the gneissic country rocks, were analyzed. Three of these samples are from the central parts of the dyke, they are clast-free and show in average a quartz-dioritic composition with SiO_2 of 50.9, 57.3 and 58.7 wt. %. The fourth rock is considered to represent the contact zone to the local bed rocks. Accessory minerals were separated and prepared for U-Pb analysis. The zircon populations extracted from the three Offset Dyke samples are free of older, inherited zircon cores, and grains show a primary magmatic appearance. These zircons are developed as euhedral, mostly transparent prisms with width to length ratios ranging from 1 : 1 up to 1 : 5. Zircons from the contact rock show similar characteristics, and, in addition, baddeleyite occurs as platy, mainly euhedral, dark red-brown crystals. Baddeleyite was not found in the three dyke samples. U-Pb data of the zircon fractions from all samples are between 1 and 4 % discordant, and three baddeleyite fractions from the contact rock yield identically concordant data, defining an age of 1847.8 $\pm$ 2.4 Ma (2σ). If baddeleyites and zircons are regressed together, an upper intercept age of 1849.4 $+3.5/-2.6$ (2σ) Ma is obtained.

Earlier U-Pb zircon and baddeleyite age determinations for the Sudbury Igneous Complex resulted in ages of 1850.0 $\pm$ 1.3 (2σ) Ma for a black norite, and 1850.0 $+3.4/-2.4$ Ma (2σ) for the mafic norite (Krogh *et al.*, 1984). Our new 1849 Ma age for the Foy Offset Dyke is in excellent agreement with these previous results. Zircon morphology and age data strengthen the view that (i) the Offset Dykes are an impact melt product, which was injected into the crushed but unmelted country rocks, and (ii) their emplacement occurred coevally with the formation of the coherent impact melt layer, i.e., the main mass of the SIC. Independend of the genetic model for the Offset Dykes, the absence of older, inherited zircon components requires total melting of the Archean gneissic target rocks at temperatures in excess of 1700°C.

In addition to the U-Pb-data we will present major, trace and rare earth element data of the Offset Dykes as well as Rb-Sr and Sm-Nd isotope systematics.

References

Brockmeyer, P. (1990) unpub. Ph.D. thesis University of Münster.
Coleman, A.P. (1905) *Ontario Bureau of Mines*, **4**, Part 3, 188.
Deutsch, A. and Grieve, R.A.F. (1994) *GRL* in press
Grant, R.W. and Bite, A. (1984) *Ontario Geol. Surv.*, Spec. Vol.**1**, 275–300.
Grieve, R.A.F.*et al.*, (1991) *JGR*, **96**, E5, 22753–64.
Krogh, T.E. *et al.*, (1984) *Ontario Geological Survey*, Spec. Vol. **1**, 431–46.
Lakomy, R. (1990) *Meteoritics*, **25**, 195–207.
Roest, W.R. and Pilkington, M. (1994) *GRL* in press.
Stöffler, D. *et al.*, (1994) *Geol. Soc. Amer.*, Spec. Vol., in press.