In two quarries lying several kilometers east and south-southwest of the crater (Otting, Aufhausen/Seelbronn), the contact between the suevite and Bunte breccia was recorded in detailed sections on outcrops of over 50 m in length.

It was possible to confirm studies made in the 1960s by Wagner [1] that suggested a division of the suevite into main suevite, rich in pancake bombs (also called "flädle"), and a relatively well-sorted, thin-base suevite consisting of fine gravel. A semiquantitative analysis of the just slightly consolidated base suevite revealed the main constituent to be "fresh," bubble-abundant, albeit sometimes bubble-deficient, angular glasses. Secondary crystalline and sedimentary rock clasts and very rarely "flädle" were detected. Significant to the transport mechanism of the base suevite is its content of Bunte breccia fragments and the discovery of shell fragments. Between the base suevite and the Bunte breccia is a crystalline breccia of ca. 0.1 m in thickness that is separated from the Bunte breccia by a sharp boundary. In some areas a transition bed is visible between the crystalline breccia and the base suevite. This transition bed indicates an erosive reworking of crystalline breccia by the base suevite. In one of the sections (Aufhausen/Seelbronn) the base suevite was not observed, as the main suevite lay either on the crystalline breccia or directly on the Bunte breccia. The crystalline breccia is highly altered and in the transition to main suevite contains disintegrated glasses.

In both sections structures were established that can be explained only by an erosive reworking of the subsoil caused by a shifting viscous suevite flow. Particulary on the flanks of the hummocks of Bunte breccia, lying several meters higher, the layers below the main suevite have been plained, compressed, and mixed by the suevite flow. In the Aufhausen/Seelbronn section hook-shaped, decimeter-sized, fingerlike compressions of Bunte breccia and crystalline breccia project into the main suevite. A clear erosive discordance between the main suevite and the base suevite is visible in the Otting section.

Reference: [1] Wagner G. H. (1965) *Jh. Geol. Landesamt Baden-Württemberg, Vol. 7,* 199–222.

SUDBURY PROJECT (UNIVERSITY OF MÜNSTER–ONTARIO GEOLOGICAL SURVEY): (7) Sr-Nd IN HETEROLITHIC BRECCIAS AND GABBROIC DIKES. D. Buhl[1], A. Deutsch[2], R. Lakomy[2], P. Brockmeyer[2], and B. Dressler[3], [1]Inst. f. Geologie, RU Bochum, Postfach 10 21 48, D-4630 Bochum 1, Germany, [2]Inst. f. Planetologie, Univ. Münster, Wilhelm-Klemm-Str. 10, D-4400 Münster, Germany, [3]Ontario Geological Survey, 77 Grenville Street, Toronto, Ontario M7A 1W4, Canada.

One major objective of our Sudbury project [1–6] was to define origin and age of the huge breccia units below and above the Sudbury Igneous Complex (SIC), i.e., the Footwall Breccia (FB) and the Onaping Formation, which caps the SIC. For the terminology used here we refer to the companion abstracts in this volume [1,3]; petrographic descriptions of the FB and of the Onaping breccias are found in [3,5,7–10].

The heterolithic FB, which is up to 150 m thick, represents a part of the uplifted crater floor [7,8]. It contains subrounded fragments up to several meters in size and lithic fragments with shock features (>10 GPa) embedded into a fine- to medium-grained matrix [8,9]. ε_{Nd}-ε_{Sr} relationships point to almost exclusively parautochthonous precursor lithologies (see Fig. 1 in [3]). The different textures of the matrix reflect the metamorphic history of the breccia layer: Thermal annealing by the overlying hot impact melt sheet (SIC) at temperatures >1000°C resulted in melting of the fine crushed material, followed by an episode of metasomatic K-feldspar growth and, finally, formation of low-grade minerals such as actinolite and chlorite. Figures 1 and 2 show that the Rb-Sr method on thin slabs and mineral fractions clearly can separate these events, whereas the Sm-Nd system apparently did not respond to either the thermal or the "late" metamorphic episode [7,8]. This is due to the fact that the highly refractory accessory phases that are the main REE carriers survived the melting in part [10].

Isotope relationships in the Onaping breccias (Gray and Green Member) are much more complex ([10–14]; compare also Fig. 1 in [3]). All attempts to date the breccia formation failed: Zircons are entirely derived from country rocks and lack the pronounced Pb loss caused by the heat of the slowly cooling impact melt sheet (SIC), which is documented in the crater basement [15]. Rb-Sr techniques using either lithic fragments of different shock stages [12], carefully separated, now recrystallized melt particles and melt matrices or the thin slab method [13,14] just set time limits for the apparently pervasive alkali mobility in these suevitic breccias. The data array

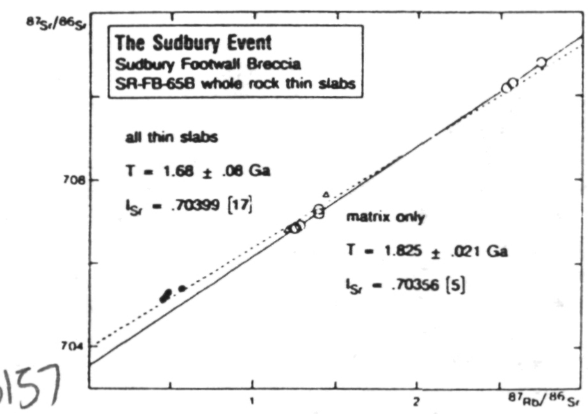

Fig. 1. Rb-Sr isochron diagram for thin slabs of the Footwall Breccia (north of Stathcona mine, Levack Township, North Range). Thin slabs of the quartzdioritic (= melt) matrix yield the age of the impact.

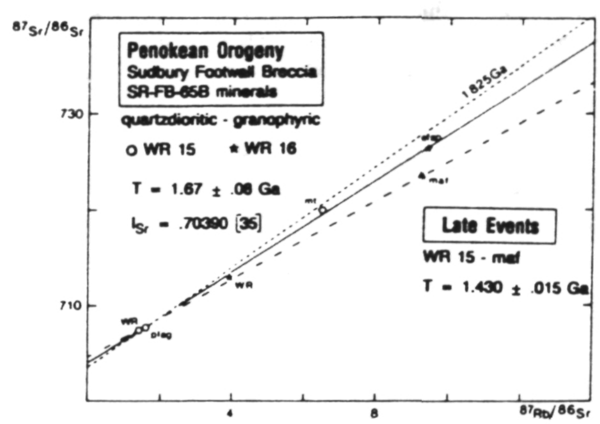

Fig. 2. Same samples as in Fig. 1. K-spar-rich granophyric matrix date a metasomatic episode; mineral fractions define a late, low-grade event.

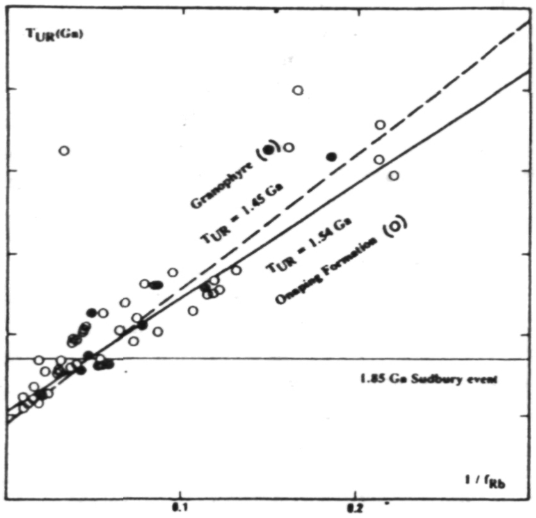

Fig. 3. T_{Ur} vs. $1/f_{Rb}$ diagram after [16] for Onaping breccias and whole-rock samples from the granophyre (SIC). Data sources [10,12–14,17,18].

and the intercept in T_{Ur} vs. $1/f_{Rb}$ plots [16] point to a major Rb-Sr fractionation around 1.54 Ga ago (Fig. 3). This model age is in the same range as 1.63 ± 0.07 Ga obtained for the metasomatic matrix of the FB (Fig. 2). It has to be pointed out that Rb-Sr whole-rock data for the granophyre of the SIC [17,18] also show this event (Fig. 3), whereas the norite behaved as a closed system during this phase.

Preliminary Sm-Nd results for gabbroic dikes of tholeitic composition that intrude Chelmsford wackes [19] are listed in Table 1. They have an internal isochron age of 1648 ± 103 Ma (2σ) with $\varepsilon_{Nd}^{T=1.65Ga}$ of -5.4. The ε-value, their model age T_{DM} relative to the depleted mantle [20] of ~2.7 Ga, and the intrusion age point to a remobilization of old crust during the Penokean orogeny, but a mantle magma heavily contaminated with crustal material may be also consistent with the data. These dikes apparently have no connection with the SIC and postdate the impact event.

Rb-Sr dating of a shock event in impact-related breccias seems to be possible only if their matrix had suffered total melting by the hot melt sheet (FB) or if they contain a high fraction of impact melt (suevitic Onaping breccias), whereas the degree of shock metamorphism in rock or lithic fragments plays a minor role [11]. In the Sudbury case, however, the impact melt in the suevitic breccias is devitrified and recrystallized, which changed Rb/Sr ratios quite drastically. Therefore, the Onaping breccias give only age limits for alteration and low-grade metamorphism. The Sm-Nd system was not reset during the Sudbury event; clasts as well as the matrix in the FB and in the Onaping breccias show preimpact "Archean" Nd isotope signatures.

TABLE 1. Sm-Nd analytical results for gabbroic dykes, Sudbury structure.

	Sm [ppm]	Nd [ppm]	$^{147}Sm/^{144}Nd$	$^{143}Nd/^{144}Nd$* ±2σ
WR	1.692	6.755	0.15139	0.511872 ± 16
coarse-grained				
plag 180-250 mm	1.009	5.302	0.11501	0.511464 ± 10
mafics 180-250 mm	2.386	9.490	0.15197	0.511860 ± 7
WR	2.619	11.86	0.13311	0.511687 ± 23

*Normalized to $^{146}Nd/^{144}Nd$ = 0.7219; 2σ errors refer to the last significant digits.

References: [1] Avermann M. et al., this volume. [2] Bischoff L. et al., this volume. [3] Stöffler D. et al., this volume. [4] Deutsch A. et al., this volume. [5] Avermann M., this volume. [6] Müller-Mohr V., this volume. [7] Deutsch A. et al. (1989) *EPSL, 93*, 359. [8] Laromy R. (1990) *Meteoritics, 25*, 195. [9] Dressler B. O. (1984) In *The Geology and Ore Deposits of the Sudbury Structure* (E. G. Pye et al., eds.), 97–136, Toronto. [10] Brockmeyer P. (1990) Ph.D. thesis, Univ. Münster, 228 pp. [11] Deutsch A. (1990) Habil-Schrift FB Geowiss Univ Mamiter. [12] Fullagar P. D. et al. (1971) *Can. J. Earth Sci., 8*, 435. [13] Brockmeyer P. and Deutsch A. (1989) *LPSC XX*, 113. [14] Deutsch A. et al. (1990) *LPSC XXI*, 282. [15] Krogh T. E. et al. (1984) In *The Geology and Ore Deposits of the Sudbury Structure* (E. G. Pye et al., eds.), 431–446, Toronto. [16] Shaw H. F. and Wasserburg G. J. (1982) *EPSL, 60*, 155. [17] Hurst R. W. and Fahart J. (1977) *GCA, 41*, 1803. [18] Gibbins W. A. and McNutt R. H. (1975) *Can. J. Earth Sci., 12*, 1970. [19] Dressler B. O. (1984) In *The Geology and Ore Deposits of the Sudbury Structure* (E. G. Pye et al., eds.), 57–82, Toronto. [20] DePaolo D. J. (1981) *JGR, 86*, 10470.

HONG KONG IS AN IMPACT CRATER: PROOF FROM THE GEOMORPHOLOGICAL AND GEOLOGICAL EVIDENCE. Chu-lok Chan[1], Wu Siben[2], and Luo Xiuquan[2], [1]Hong Kong Amateur Astronomical Society, Hong Kong, [2]Institute of Mineral Deposits, Chinese Academy of Geological Sciences, China.

Hong Kong is a famous city in southern China, 22°19'N, 114°10'E, within which the urban districts of Hong Kong, Kowloon, and Victoria Harbour are situated. Hong Kong is surrounded by mountains with a diameter of 11 km. Three million people live inside the basin.

The round structure of the mountains in Hong Kong has been described as a granite dome that is deeply eroded (batholith). In this paper, the circularity of the mountains, the existence of a central hill, the inner slope of the mountains being greater than the outer slope, the presence of deep layer rock inside the basin, and the depth-to-diameter ratio have been studied. All this evidence shows that the Hong Kong structure satisfies the geomorphological requirement of an impact crater.

Some shock metamorphic phenomena of the rocks in Hong Kong such as planar features, microspherilitic silica glass (lechaterlierite), fused margins of rock fragments, concussion fractures, impact glass in which some schlierens are consistent with pyroxene spiculites, etc., were first discovered in October 1990. In Hong Kong Island, an impact melt sheet has been observed from the Victoria Peak to the southern shore. Quenching fractures of quartz in Kowloon fine-grained granite has also been discovered.

In our work, the K-Ar age (83.34 + 1.26 m.y.) of the impact melt rock, which is younger in comparison to the K-Ar age (117 m.y.) in Hong Kong and Kowloon granite, has been measured, and the phenomena indicate that after the granite body formed, there was another geologic event. Maybe it is the Hong Kong impact cratering event.