

## THE LAKE SAARIJØRVI - A NEW METEORITE IMPACT STRUCTURE IN NORTHERN FINLAND.

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**Summary.** Petrographic analysis of drill core samples, supported by geophysical and geological data, confirm that Lake SaarijØrvi, Taivalkoski, northern Finland, is a remnant of a deeply eroded impact structure. It is the eighth impact structure found in Finland.

**Background.** The SaarijØrvi structure has been a target of investigation for more than 60 years. Three explanations for its origin have been offered: (i) a tectonically downfaulted sedimentary unit, (ii) a kimberlite pipe, or (iii) a meteorite impact [1, 2, 3, 4, pers. com. by S. Elo]. In order to find out the real nature of the structure, Malmikaivos Oy, a Finnish exploration company, carried out a deeper drilling into its center (Fig. 1a). Here we summarize the morphological, geophysical, geological, and petrographic data for the structure.

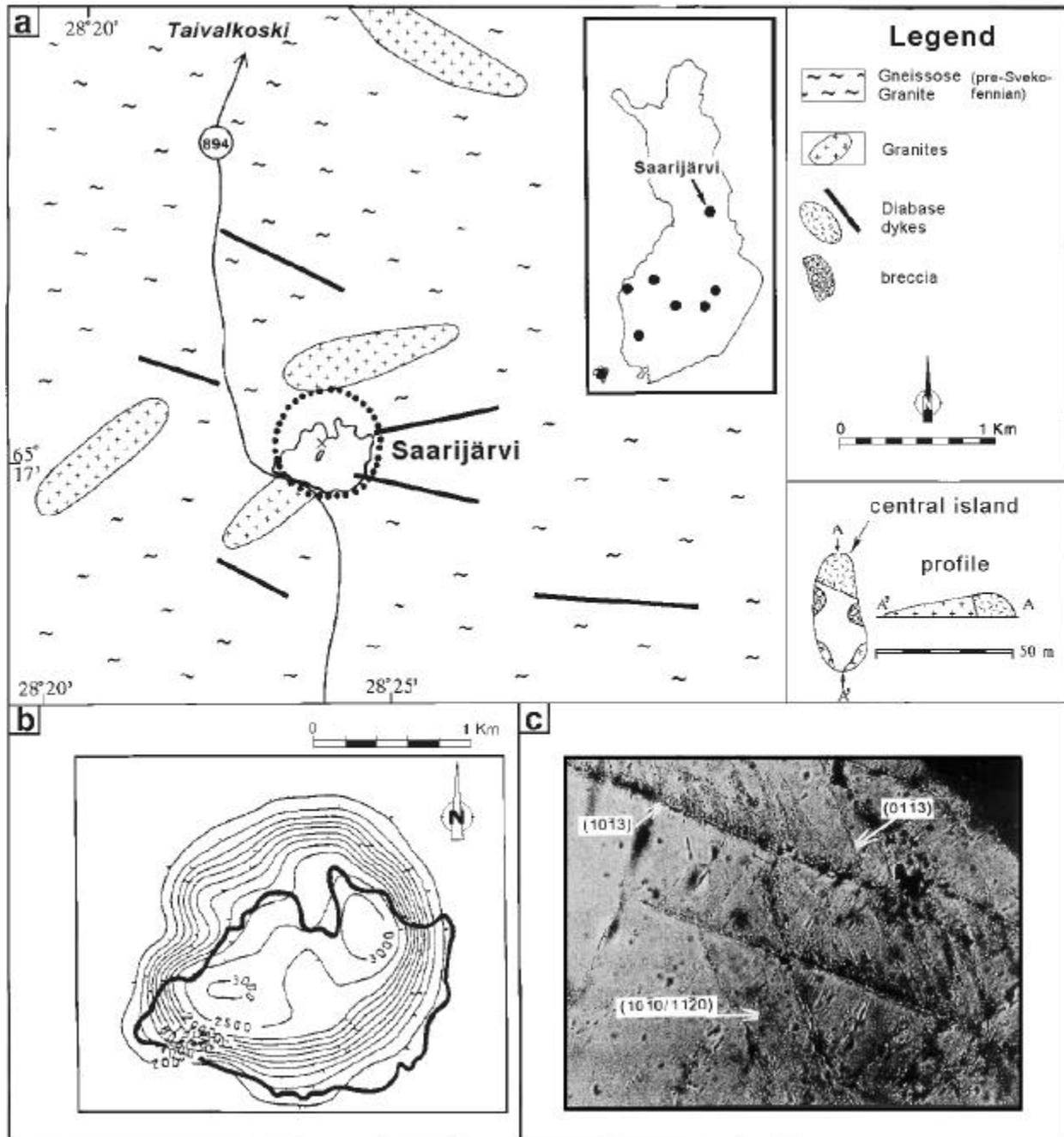
**Geological setting.** The SaarijØrvi impact site (center co-ordinates 65°17.4'N 28°23.3'E) is visible in Landsat satellite images as a roundish structure with a diameter of ~1.5 km. The structure occupies the present lake SaarijØrvi extending slightly to the north into a topographically low area. Geologically the structure lies in the pre-Svecofennian (Archaean) basement of the Suomussalmi block. The main target rock type is tonalitic, gneissose granite rich in oligoclase. The bedrock is cut by diabase dykes of different ages as seen by high-resolution aeromagnetic maps and in outcrops including the central island (Fig. 1a). Within the structure proper, on top of the basement, there exists an up to 156 m thick sedimentary unit with varieties of sandstones and claystones. The central drilling penetrated the sedimentary pile up into fractured basement gneiss. A few centimeter thick breccia layer was found at the top of the fractured basement just below the sediment. Moreover, two anomalous mafic veins cut the fractured basement, which is below them less fractured. Two breccia outcrops were also discovered on the central island (Fig. 1a).

**Geophysical observations.** Strikingly circular aeroelectromagnetic and ground electromagnetic anomalies are associated with the Lake SaarijØrvi structure (Fig. 1b) [2, 6]. They are partly related to the lake water and bottom mud of Quaternary age, but partly reflect deeper located conductors, presumably breccia layers or fractured bedrock. The aeromagnetic data show a generally weak signature over the lake, and some of the linear aeromagnetic anomalies due to mafic dykes appear to be truncated by the structure. The gravity data reveal a negative Bouguer anomaly of about -1.5 mGal over the structure. These geophysical data are consistent with an impact origin of the structure [4].

**Petrographic observations.** Previous petrographic investigations of shallow drill cores have failed to show definite shock metamorphic features (Lehtinen, M., 1993, unpubl. data). Petrographic observations of a breccia sample of the new drill core from 156.38 m depth reveal, for the first time, evidence for shock metamorphism. This sample is a very fragile breccia with conical clasts of quartz and granite.

In thin sections, some of the quartz clasts show planar deformation features (PDFs) with three orientations (011; 3, 101; 3 and 101; 0/112; 0; Fig. 1c). Some biotite grains show kink bands and feldspar reveals mosaicism. These petrographic results clearly demonstrate that the rock has been shocked to a peak pressure over 15 GPa. Petrographic investigations of the samples from the *in-situ* breccia of the central island showed also shock effects, but of weaker nature than observed in the drill core. We conclude that SaarijØrvi is a deeply eroded remnant of an impact structure, somewhat similar to the Iso-Naakkima structure, Finland [7]. In the current data base of Finnish impact structures it is number eight. The age of the SaarijØrvi impact event is still unknown, but can be constrained to be older than 0.6 Ga, which is the approximate microfossil age of the subsequently infilled sediment [5], and younger than 2.45 Ga, which is the probable age of the diabase dykes. If the central island, with its breccia outcrops, turns out to be a remnant of a central uplift, the original diameter of the structure must have been much larger than the presently seen diameter of 1.5 km. Indeed, some of the "tails" in the gravity data hint to a larger structure. We present geophysical and petrographic results of the SaarijØrvi structure and discuss its implications for impact cratering in Fennoscandia.

**References.** [1] Hyypö, J. and Y. Pekkala, 1987. Tutkimustyön selostus Taivalkosken kunnassa valtausalueilla SaarijØrvi 1-3 suoritetuista savikivitutkimuksista. Geologian tutkimuskeskus, Raportti M 06/3533/-87/1/89. [2] Elo, S., Jokinen, T. and P. Turunen, 1983. Geophysical investigations of the SaarijØrvi structure. In: L. Eskola (ed.), Geophysics for Geologists, Geol. Surv. Finland, Report of Investigation 58: 101-116 (in Finnish). [3] Henkel, H. and L.J. Pesonen, 1992. Impact craters and craterform structures in Fennoscandia. Tectonophysics 216: 32-40. [4] Pesonen, L.J., Lehtinen, M., Tuukki, P. and A. Abels, 1997. The Lake SaarijØrvi structure, Taivalkoski - a new meteorite impact crater in Finland. In: P. Kaikkonen, K. Komminaho and H. Salmirinne (eds.), Negotiating Days of the Applied Geophysics, Univ. of Oulu, Finland (22.10-23.10.1997), p. 8-9. [5] Tynni, R. and A. Uutela, 1985. Myöhäis-prekambrinen ajoitus Taivalkosken savikivelle mikrofossiilien perusteella. Geologi 4-5: 61-65. [6] Turunen, P., 1995. VLF-R- ja tasa-virtamittaukset Taivalkosken SaarijØrvi- ja Tyrön raportti, Q 19/3533/1995/1, Geol. Surv. Finland, Regional Agency, Rovaniemi, 14 pp. [7] Elo, S., Kuivasaari, T., Lehtinen, M., Sarapää, O. and A. Uutela, A., 1993. Iso-Naakkima, a circular structure filled with Neoproterozoic sediments, Pieksämäki, southeastern Finland. Bull. Geol. Surv. Finland 65 (1), 30 pp. [8] Pesonen, L.J., 1996. The impact cratering record of Fennoscandia. Earth, Moon, and Planets 72: 377-393.

**Fig.1**

(a) Inset: The location and general geology of the Lake Saarijärvi impact structure in northern Finland (also shown are the seven other known impact structures of Finland (cf. [8])). For rock types, see legend. Note that there is a central island in the lake where two breccia outcrops have recently been discovered [4]. The cross denotes the new drill site.

(b) Ground electromagnetic (Slingram, in-phase component) anomalies associated with the Saarijärvi structure [6].

(c) Multiple sets of PDFs in the breccia layer of the drill core at 156.38 m depth.