

KEURUSSELKÄ - A NEW IMPACT STRUCTURE IN CENTRAL FINLAND. S. Hietala¹ and J. Moilanen²,
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Introduction: We have discovered evidences of a previously unknown impact structure in Finland [1].

The structure is hereafter called as Keuruselkä impact structure after the lake Keuruselkä which is partly covering it in NE and SW directions.

Collected rock samples show evidences of shock metamorphism i.e. shatter cones and planar deformation features.

The Keuruselkä impact structure is covering at least 9.5 km wide round area.

Location: The Keuruselkä impact structure is in Central Finland, 220 km north from Helsinki and 60 km west from Jyväskylä. It is only 32 km west from a small Karikkoselkä impact structure found in 1995 [2].

The impact structure is situated on a broad land area that divides the lake Keuruselkä into two narrow waterways (Fig. 1). The lake Keuruselkä is a 27 km long lake between towns Keuruu and Mänttä and a part of it is in Vilppula.

According to our mapping of in situ shatter cones, the structure is centred at 24°36' E and 62°08' N.

Discovery: One of us (S.H.) found first shatter cones in boulders in mid November in 2003. Later in November and December we explore the area more closely and we found numerous shatter cones both in situ and in boulders (Fig. 2).

Many shatter cone samples were collected in different parts of the structure. Also one breccia boulder was found. We also collected samples outside the structure for reference.

Shatter cones in situ: Shatter cones are present in outcrops throughout the 9.5 km diameter structure. However, shatter cones are restricted inside a 12 km wide area, so the diameter of shatter cone area seems to be between 9.5 km and 12 km.

Shatter cone features were found in situ at 25 places. In many places they are well developed and it is easy to make difference between them and tectonic deformation surfaces.

Orientations of measured shatter cone features point roughly to the centre of the structure.

Shatter cones were observed in porphyritic granites, metamorphic rocks such as gneisses and also in granodiorites and metavolcanic rocks. Some of rocks were strongly mylonitised.

Planar deformation features: One found breccia boulder (granitic fragmental breccia) was taken to analyse to the Department of Geosciences, University of Oulu. Analyse of thin sections by optical micro-

scope revealed shock metamorphic features in the sample: planar fractures (PFs) and planar deformation features (PDFs) [3]. PDFs were observed in many quartz grains (Fig. 3). Possible PDFs were observed also in other tektosilicates.

Closely spaced PDFs in quartz grains occur in 1 to 3 sets and they are distinctive. High magnification reveals that PDFs are partially decorated e.g. arrays of fluid inclusions in lamellae are visible. U-stage measurements of PDFs orientations have not been done yet.

Quartz veins in the breccia specimen are recrystallized and it also seems to be hydrothermally altered, which could be a result of post impact hydrothermal activity.



Fig. 1: Location of the Keuruselkä impact structure. A grey round area in the map shows a 9,5 km wide area where shatter cones were found in situ.

Other features: The Keuruselkä impact structure is not clearly occupied by a lake like most of known craters in Finland. No distinct round topographical depression, crater rim or central uplift is to be seen.

The aeromagnetic map shows some circular features in the area. Granitic intrusions, magnetite or pyrites could cause them and it seems that these fea-

tures does not clearly match with the observed structure.

Preliminary petrophysical analyses of samples show that bedrock where shatter cones were found has density of 2508-2922 kgm⁻³ [3]. Comparisons between rock samples from inside and from outside the structure needs to be done in future.

Age: Age of Keurusselkä impact structure is undefined until further research is done. However, the structure is on Central Finland Granite Complex of Paleoproterozoic age (1890 - 1880 Ma), which is mainly composed of synorogenic granitoids. Shatter cones seems to be present in all rock types of the region, thus the maximum age of the structure must be younger than ~1880 Ma age of target rocks.

Discussions: Shatter cones in situ and in boulders have been found in great number at the Keurusselkä structure. Morphological and field discoveries show basis that the structure represent deeply eroded remains of large complex impact structure which present day erosion level is below the original crater floor.

A central uplift or its remains has not been found so far. At this point it is impossible to say for sure is the 9.5 km structure an eroded root of the whole crater or just an eroded root of the central uplift. In later case, some traces of original impact structure would be found in much wider area.

This hypothesis of almost completely eroded impact structure is supported by reference to the e.g. distribution of shatter cones on a circular area and in the other hand the missing depression.

Deep erosion of the impact structure seems to be a probable explanation for the lack of impact melts and breccias. It seems also possible that the structure has gone through tectonic modification.

Gravity data of this region is not yet been published. Further study of the structure would need gravity and seismic data.

In 1968 a Finish mining company, while looking for ore deposit, already drills the area. Because this, there are three drill cores available only couple of kilometers south from the centre of the structure. These drill cores needs to be study more closely in future.

Conclusions: Both shatter cones and PDFs in mineral grains have been used as definite evidence of meteoritic impact origin [4, 5]. Shatter cones indicate shock pressure of at least 2-6 gigapascals (GPa) and PDFs in quartz indicate shock pressure of ~7-35 GPa [5].

Since both shatter cones and PDFs have been found at Keurusselkä structure, we conclude that the shock-metamorphosed rocks at Keurusselkä structure show traces of a meteoritic impact event.

All foregoing evidences at this far prove that the Keurusselkä structure is the 11th impact structure found in Finland.

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References: [1] Hietala S. And Moilanen J. (2004) *Tähdet ja avaruus*, 1/2004 (in print). [2] Lehtinen L. et. al. (1996), *LPS XXVII*, 739-740. [3] Öhman T. (2003), *Oulu University*, personal communication. [4] Koeberl C. (1999), *Oklahoma Geological Survey Circular 100*, 30-54. [5] French B. M. (1998), *LPI Contribution No. 954*, 120 pp.



Fig. 2: Shatter cones in a large boulder on the shore of the lake Keurusselkä. The lens cover is 5.5 cm wide.

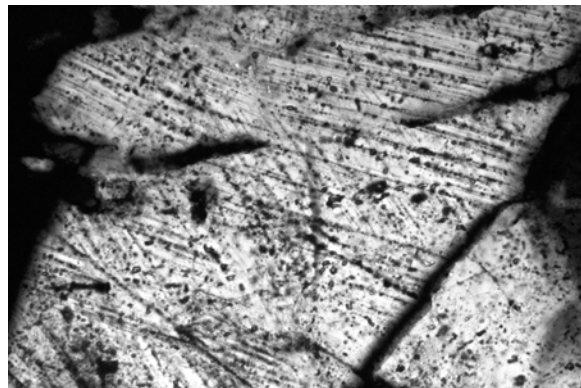


Fig. 3: A quartz grain from breccia sample with partially decorated multiple PDFs at least in two directions. The photograph is 0.3 mm wide (cross-polarized light). Photo: Teemu Öhman, University of Oulu.