Miarolitic pegmatites of the Viborg rapakivi granite massif, SE Finland,

with special attention to the green gem beryl producing Karelia Beryl Mine pegmatite at Luumäki, Karelia.

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Abstract

Since the 1970's the rapakivi granite of the Viborg massif in SE Finland has been known for miarolitic pegmatites, some of them producing excellent smoky quartz, fine topaz and since 1984 world class gem heliodore crystals.

During 2002-2004 some of Europe's, and among the world's finest green colored, etched gem beryls have been unearthed from the Karelia Beryl Mine, Kännätsalo, Kiwijärvi, near Luumäki, Karelia, Finland. The well zoned, highly fractionated REE pegmatite is located within the Viborg rapakivi A-type granite massif, which is an approximately 1650 Ma anorogenic intrusion.

Geology in short

The Viborg rapakivi granite covers large areas of SE Finland and consists of several varieties of granite. Rapakivi granites have intruded into Svecokarelian granitoids, gneisses, schists and metavolcanites (Lahti 1993). In 1891 J.J. Sederholm introduced the word rapakivi granite in international geological literature in his pioneering work on rapakivi granites of southern Finland. The Finnish word rapakivi means "rotten stone" or as the Finns put it "disintegrated or crumbly" rock due to its typical higher weathering tendency than most granitic rocks. Geochemically the rapakivigranites are subaluminous A-type granites with high LREE and HFSE except for Eu. The rapakivigranites in Finland, Russian Karelia, Sweden, Estonia and elsewhere in the world (Ukraine, Brazil, Canada, Greenland etc) have been intensely studied from many perspectives. The tectonic setting is an anorogenic extensional and formed by remelting of pre-existing lower crust in response to thermal perturbations associated with underplating. The bimodal magmatism i.e. the association of rapakivi granites (granites, silicic dikes, anorthosites and gabbroids, mafic dikes) has led many researchers to suggest magmatic underplating as the probable mechanism for the generation of these rocks (Haapala and Rämö 1999 and references therein). The role of mantle mixing has also been discussed by several authors (Eklund et al. 1994, Salonsaari 1995, Kosunen 2004). Many rapakivigranites are associated with anorthositic and gabbroic complexes and this is the case with the Viborg Batholith as well. The origin of interference colors has been described by Lahti (1989).

The world famous spectrolite carrying anorthosite mined booth for decorative stone and gemstone at Yläämа is one of these dark intrusive complexes. It shall be noted here that for gem specimens and for cabochons, the Karelian spectrolite is considered as the very finest in the world with its multitude of bright peacock feather colors ranging from dark blue to blue, blue-green, green, greenish yellow, yellow, over orange tones to golden to red and purple. A specimen with a 15 cm large perfect multicoloured crystal in matrix which the author collected in an old abandoned quarry on June 23, 1995 is exhibited at the New York Museum of Natural History, while a smaller one is still in the author's collection.

Age dating of the Viborg batholith (Vaasjoki.1977, Vaasjoki et al. 1991, Suominen, 1991) on zircon (U-Pb) show the rapakivi granite to be between 1.65 and 1.54 GA old. The Viborg batholith is given an age of 1.67 – 1.62 GA by Rämö et al. (2005). The anorthosite has been age dated by U-Pb in zircon and was determined to 1633 +- 2 Ma (suominen 1991, Vaasjoki et al. 1991) and the associated granite was dated to 1633+- 5 Ma (Suominen 1991).

Geophysical studies (Elo and Korja, 1993; Korja et al., 1993; Luosto, 1997; Korsman et al., 1999) show that the Fennoscandian rapakivigranite batoliths are relative thin (5-10 km) sheet like bodies in the upper part of the crust, and that the crust in these areas show a particularly steep ovoid thinning of around 20 km in the center over these regions. Just off the Finnish coast (Rämö and Korja, 2000; Rämö et al. 2000, Rämö et al., 2005) south of Kotka the crust is approximately 39 km thick whereas some 200 km to the northeast it is up to 63 km.

The rapakivi granites are anorogenic, i.e. not associated with the formation of any mountain building event (orogeny). The crust underlying the rapakivi intrusions are seismic reflectors and the lower crust is thinned as well (Korja et al. 2001, Rämö et al. 2005) with large Bouguer gravity minima (-20 to -40mgal) (Korja et al. 2001).

The Finnish rapakivi granite batholiths consist of several granite types with smaller bodies of anorthositic or gabbroic bodies. Contact relations between the later and the rapakivi granite suggests the rapakivi granites to be younger (Rämö et al. 2005) and isotopic data support this conclusion in part, although the age difference is marginal as noted above. The anorthosite is sometimes crosscut with apparently younger granitic pegmatites, which support the crystallisation sequence (field studies by the author 1995-2005).The contact between the two is sharp. Reports by from other rapakivi terraines also suggest the same crystallisation history (Savinikh 1937, Frost et al 2002). The oldest rapakivi are fayalite-bearing biotite-hornblende granite.

The major parts of the intrusive granitic rocks are viborgite (Rapakivi granite proper sensu strictu), a biotite-hornblende granite with K-feldspar ovoids typically 1-10 cm in diameter with an oligoclase rim and pyterlite (biotite granite with a mantled K-spar ovoids) (Rämö et al. 2005). The youngest intrusive phases are topaz bearing microcline-albite granites containing lithian siderophyllite (or prolithionite) as the dark mica (Haapala, 1997), with a Li content of 1.2-1.6 % Li_2O and F content of 4.2-4.9 % (Haapala 1991) and very high Fe/(Fe+Mg) ratios (0.92 to 1.00) with structure polytypes at Kymi (2M1 and 3T). Vorma (1971, 1976) lists typical associated minerals in the main intrusion phases as fluorite, zircon, allanite, apatite, anatase, magnetite and ilmenite. In the biotite granites (pyrolite) there is no allanite but monazite. In the late stage topaz carrying granites, cassiterite, columbite, ilmenite, monazite and bastnäsite are typical (Haapala 1974).

Pegmatites and miarolitic cavities are so far judged to be rare in the rapakivi granites. Late crystallisation of F-poor biotite, weak subsolidus reactions, and scarcity of hydrothermal veins and mineral alterations indicate that the early intrusive phases crystallised generally from water-undersaturated melts (Rämö 2005). The last intrusive phases crystallised from water saturated magmas (Haapala 1997, Haapala and Lukkari 2005), as is quite clear with the miarolitic pematites as evidence (Lyckberg 1997). This author suggests that in the Viborg batholith these may not be so rare after all. Most granitic intrusions only show local pegmatite rich areas (depending on type, fractionation but not least the level of exposure within the intrusion) and the miarolitic carrying parts are rather restricted vertically. Typical examples are the Erongo aquamarine carrying miarolitic granite (tube like or vein type pegmatites to hydrothermal tubes) of Namibia, the Adun Chelon granite with miarolitic beryl and topaz carrying pegmatites of Transbaikal (Siberia), Russia (Lyckberg 2001, Lyckberg 2006). At these sites granites are quite well exposed and it is clear that the miarolitic pegmatites are very localised on a big scale. In the rapakivi granites of the Korosten pluton in Ukraine the chamber pegmatites carrying smoky quartz, topaz and beryl (+103 other minerals, Dr. Panchenko mutual communication 1995) occur in a 22 km long and a few kilometer wide belt in clusters between the surface and 150 meters depth (visit 1995, Lyckberg 2001). The extension of miarolitic chamber type pegmatites and miarolitic vein type pegmatites in the

Viborg batholith may not yet have been properly investigated, as this is quite a specialised but mineralogically, geologically and geochemically interesting subject.

The prohibitively expensive method used in Ukraine was core drilling in a grid with 50 meters in between each drill hole. During a visit the author asked the chief geologist (Dr. Panchenko) if no geophysical method (seismic, geo radar) was used to localise clusters of clay filled miaroles after draining of the local bedrock, but this was not confirmed.

Notes on a few miarolitic pegmatites in the Viborg rapakive granite

The road cut pocket

One of the first large pockets in the Rapakivi granite of SE Finland was made in the late 1970's. A giant pocket encountered while building a road through the forest between Luumäki and Virolahti, produced black smoky quartz (morion) to at least 50 cm (seen, to 1 m rumoured) in length and 15-20 cm in diameter (Lyckberg 1997). The roadcut was widened to a small quarry as there was a need for filling material for the road bank nearby. During the work several pockets were encountered, the largest one measuring 4-5 m in length and producing over a ton of smoky quartz crystals. Most crystals were gathered by local road workers and mineral collectors who traded them in Finland. One crystal of 40 cm in length reached Göteborg in Sweden in the early 1980's. The main pocket itself was just at the eastern edge of the road, where there are still (1995, 2005) small boulders of granitic, rather small grained pegmatitic material which show abundant small cm cavities and pocket signs.

The giant Morion Pocket at the river N of Loviisa discovered by the Krogars brothers

During the blasting work in 1992 widening a river north of Loviisa in the Swedish speaking part of SE Finland, the two brothers Kaj and Helge Krogars, who had just became interested in mineralogy, found a 2 m wide white quartz pod. They took a few samples of the quartz since it looked as if there were micro quartz crystals in fissures. They had access to a microscope and studied the samples. With the beauty of the tiny, few mm clear quartz they decided to return and bring some more samples. While hammering on the large quartz pod, it suddenly broke and it collapsed into a giant, chamber type miarolitic pocket. The upper 0.5 m of the pocket was empty, i.e. airfilled that is. The pocket measured 3x3x4 meter and was filled 3.5 meter with hypergene clay in which there lay dozens of giant quartz crystals of a beautiful black color (morion). The largest measuring well over a meter in length and over 100 kg in weight. The total weight of smoky quartz crystals shall have exceeded 4 tons (Lyckberg 1997).

The pegmatite geometry and mineralization was very similar to the before mentioned world famous topaz and heliodore carrying ones at Volodarsk, Ukraine, given the name chamber type pegmatites. It was asymmetric as to mineral content just as Volodarsk chamber pegmatites. One single giant chamber taking much of the pegmatite volume and weak hydrothermal alteration corresponds to Volodarsk type 3 pegmatites, also with one chamber (Lazarenko 1973, Zagorsky 1999). Typical for a classic chamber type pegmatite is one large cavity filled with quartz of mostly smoky color and of hypergene rusty clay under a solid (often white) quartz cap similar to pockets seen in situ in Volodarsk, Ukraine, by the author during an underground visit to the Volodarsk Mine in September 1995 and studied in situ in Loviisa in June 1995. Most of the largest quartz crystals have formed from the roof and most often they have collapsed into the pocket. This was the case at Loviisa and in most pockets in Ukraine. In the bottom part of the pocket at Loviisa there were also a few fine specimens of purple-green, cubic fluorite to 8-9 cm on an edge, recovered in groups to 25 cm (visit 1995). Many of the large smoky quartzes were beautifully doubly terminated and although not quite as sharp and lustreous as the world famous Tiefengletscher found in 1868 in the Swiss Alps, this would be the most significant Nordic equivalent in terms of giant well terminated morion. In their own right they deserve more attention than they were given.

The only beryllium mineralisations nearby this mega morion pocket, found by the author in 1995, were crude reddish brown danalite/helvite(?) in aggregates to half a kilo (10 cm), found only some 10 meters from the pocket in association with K-feldspar, muscovite and pyrite (Lyckberg 1997). The material from the bottom of this pocket should yield interesting results and clues to a more complete picture of its mineralogy and such samples were collected by the Museum of Natural History in Helsinki (Helsingfors University) before the pocket was completely removed by blasting work.

It was clear that F-mineralisations were located at the bottom part of the pocket. Many geologists have studied syngenetic miarolitic pegmatites. One issue on everyones mind and often mentioned is multiple adiabatic pressure drops during pocket formation, which resulted in boiling of residual melts and siolutions. An especially abrupt pressure drop is related to the polymorphic transition of high-T quartz to low T-quartz. Pressure drops during the formation of cavities are results of shrinkage of surrounding rocks, depressurization of miarolitic cavities to escaping fluids into surrounding pegmatite (pocket eruption) and tectonic faulting and displacements (Dolgov 1963, Trufanov 1968, Zakharenko 1972, 1975).

The location of this pocket is on the south edge (left bank) of a river just west of a westerly bend, 4 km ESE Hindersby and 12.5 km NNE Lovisa.

It is a pity that not at least the remnants of this mega pocket was saved in situ as this would have been an exceptional geologic object to preserve on site, as worthy as any "swamp with birds" or what it might be. Not with any intention to degrade flora and fauna, but rather as a suggestion to start a more serious approach to save well exposed geological object of great interest. Usually interesting roadcuts or other exposures are quickly covered by soil and grass, as there is little knowledge and understanding among the general public to the interest and value of such sites. The surrounding area does certainly have a high potential for further miarolitic chamber pegmatites and is worth a serious study.

Miarolitic topaz bearing pegmatites at Virolahti

Rapakivi granite (pyterlite) is being mined at Virolahti (Haikanvuori quarry) in the very SE corner of Finland only 5 km from the Russian boarder. During the last decades meter sized pockets producing white to pale blue well-developed topaz crystals have been encountered in pegmatites. The crystals attain 10 cm in length. Other minerals in the cavities are alkali feldspar, quartz, biotite, fluorite, albite (cleavelandite), fluorite, calcite, tourmaline and some beryl (Kinnunen 1987, local Finnish collectors and geologists mutual communication). The pyrelite is more silicic than the viborgite. It has been mined since the 16^{th} century.

The Kymi topaz deposit (Kymi stock)

10 km north of the coastal town of Kotka a 6x2.5 km cupola shaped intrusion of topaz bearing alkalifeldspar granite cuts the viborgite, pyterlite and porphyry aplite of the Viborg batholith. The intrusion consists of two rock types (Haapala 1977, Haapala and Lukkari 2005): a porphyritic central granite and an equigranular marginal granite. Both are leucocratic alkali feldspar granites with Li-enriched dark mica and accessory topaz. The central porphyritic granite appears to be slightly older than the marginal equigranular granite and stockscheider pegmatite (Haapala and Lukkari 2005). The Nd isotopic composition is identical for the two granites at 1.64 Ga, thus slightly higher than what has been measured for viborgite in the south-central part of the batholith (Rämö 1991)

The Sn content of the micas is 250-300 ppm (Haapala 1977). Accessory minerals include monazite, columbite, bastnäsite, thorite, pyrochlore and molybdenite. Both granites are geochemically peraluminous and have a high anomaly of Li, Be, F, Rb, Sn, Nb and Ga and a low anomaly of Ti, Fe, Mg, Ba, Sr and Zr (Haapala 1977, Rieder at al. 1996, Haapala and Lukkari 2005) Access is from highway 357.

A topaz rich pegmatite granite and pegmatite (stockscheider) zone carrying clear topaz crystals, somewhat similar to classic Scherlova Gora greisen deposit of Transbajkal, Russia (Lyckberg 2001) occurs at the contact between the Kymi stock and the surrounding viborgite and pyterlite. It is several meters wide and the main minerals are K-feldspar (often light green amazonite color), two generations of albite, quartz, biotite (mainly as extensive dendritic clusters), topaz, tourmaline, beryl, comumbite, monazite, cassiterite, fluorite, phenacite and molybdenite plus other sulphides. It is being mined for the clear, gem quality topaz crystals by local mineral collectors and gem cutters. Typical crystals are rather small and only 1-2 cm in size. Length is approximately 1.5 times diameter. The pegmatite would be classified as a NYF pegmatite according to Cernys NYF-LCT classification.

The Karelia Beryl Mine at Kännätsalo, Kiwi Järvi, Luumäki, Karelia

The mining site is called Karelia Mine in official mining claim papers. The company mining the property is registered as Karelia Beryl Oy.

In 1982 the first fragment of clear color less topaz was found at a roadconstruction site in Karelia Finland by Kauko Saurinen (personal communication 1995). Mr Saurinen believed it to be clear quartz, but was positively surprised when he was going to facet it and it was identified as topaz.

A pegmatite running parallel to, and partly under the road was later claimed by this local gemstone enthusiast and gem cutter together with his partner Matti Lang and Risto Pitkanen. Mining work starting in 1984 revealed at least one major gem beryl pocket in this granitic pegmatite near Luumäki in southern Finland (personal visit 1995).

One initial gem beryl carrying pocket reported to the author in 1992 (personal information from Risto Pitkänen) was found straight below large nontranslucent common beryls up to a meter in length, having been dissolved attheir base where also mineralisations of radioactive minerals were found (monazite etc) and flawless gem beryl occuring in rusty hypergene clayfilling the pocket. Risto Pitkänen also reported chalcedony-jasper filling of pockets and one rare sample was recovered with a gem beryl in matrix.

The total production until 1995 was around 15 kg of gem beryl (Risto Pitkänen and Kauko Saurinen, personal communication 1995), most of it having been found in the early days of mining. The beryl ranged from rare dark almost olive green, to green, yellowish green to true golden yellow heliodore color. This deposit subsequently produced some significant crystals and gemmaterial (see A. I. Lahti and K. A. Kinnunen, "A new gem beryl locality: Luumäki, Finland," Spring 1993 Gems & Gemology, pp. 30-37).

Homogenisation temperature of pocket material was studied by Lahti (1993) by fluid inclusion studies and was determined to 370-390 °C with a salinity of 7,3-7,5% NaCl equivalent. Lazarenko (1973) gives crystallisation sequences for minerals in the Volodarsk miarolitic pegmatites. There beryl crystallised in the end of the pneumatolythique and in the beginning of the hydrothermal phase around 540-470 °C. Topaz however was shown to have crystallised during bthree distinct sequences (660-620, 510-410 and 320-280 °C respecteively while 3 fluorite were crystallising at around 520-480, 420-370 and 240-60 °C. Pressure was estimated to 0,2-1,0 kBar with pressure corrected crystallisation temperature to 400-490 °Celsius at Luumäki by Lahti (1993).

Stones were cut principally in Idar Oberstein and Finland. Few specimens reached the mineral specimen market, simply because there were so few found and collectors at the time were not prepared to pay the gem value of the material.

Although the deposit has yielded several large pockets from areas adjacent to quartz core and in the core itself none of these contained any beryl mineralization. Topaz occurred sporadically in the pegmatite and most commonly as larger chunks 10-20 cm in size, most often of a white to greyish white color, with crystal shape or as heavily fractured masses. Small clear cleavage pieces to a couple of centimetre were facetted and are colorless to light blue.

From the early days of mining at Luumäki the gem beryl crystal "Miss Ellie" in the Museum of Helsingfors/Helsinki University (Museum of Natural History) is the most significant and of true world class. "Miss Ellie" was found in 1986 and is a rounded etched hexagonal doubly terminated long-prismatic green gem beryl weighing approximately 450 gram. At the same time the three Finnish gem beryl pioneer miners also found even a larger crystal (around one kilo 950 g?) of also very good quality and fragments and smaller crystals from olive green to pure heliodor color. Some blue aquamarine was produced from the green beryl by heat treatment as a curiosity. After the 1995 mining season the Luumäki deposit was reclaimed (filled in and covered by soil).

History of the giant gem Beryl pocket mined 2002-2004 and found by Timo Römkä and his team

Since October 2002, renewed work at this deposit (known as the Kareliaberyl mine) by a newly formed mining company Karelia Beryl Oy has yielded the most significant gem beryl crystals ever found in western Europe i.e. within the European Union. The best of the crystals are just about as good as any green beryl or yellowish-green etched "heliodore" crystals yet discovered. The before unrivalled ones were found as a by product during piezo quartz mining at the Volodarsk, Ukraine between 1941 and 1995 when the mines were closed down. Renewed mining has started here in 2005 by first pumping some of the shafts and tunnels at 50 and 100 m level but so far no finds of gem beryl has been made.

It should be said that hundreds of chamber pegmatites were mined here in a 22 km long and 1.5-5 km wide zone (the zone is in fact even wider but this section has the high concentration of miarolitic pegmatites). The zone is in the exocontact of the Korosten gabbro-anortosite massif. They form a N-S trending field called the Korosten pegmatite field, known as Volodarsk Volynsk (Volhynia) where Volodarsk is the town of 10 000 inhabitants of which 1500 were employed by the mining company and Volynsk is the region.

These gem bearing topaz and beryl miarolitic pegmatites are within the contact zone between the basic rocks and granitoids and close to the granites with fine-ovoid texture and fine-grained matrix. Within the granite intrusion there are three distinct granite types where the one holding most gem pegmatites has a porphyritic texture with poikilitic matrix (Lazarenko 1973). This zone coincides with the zone of magma feeding fault (Zagorsky 1999). The pegmatites form groups, clusters or short chains of bodies usually extending parallel to the contact of the granites and basic rocks and the largest miarolitic pegmatite bodies are located in the center of each group. Each congregation of miarolitic pegmatites have a surface area of up to 100 000 m^2. These well-documented data by Soviet geologists during mining may be useful as a comparacy for further studies of the Viborg massif and other rapakivi granites.

The Götemar granite has a slight potential and some miarolitic pegmatites yielding gem topaz to 4 cm was found in a granite quarry at Kråkemåla, NW of Oskarshamn on the Swedish east coast (Lyckberg 1997, Kresten 1976, Kresten and Chyssler 1986), and there may be many more areas of the earth which deserve further studies.

Production statistics at Volodarsk show that as much as 10 % of the pockets yielded topaz, often in gem quality crystals but only 1 % yielded beryl and only a fraction of it in gem quality (Chief geologist Panchenko. personal communication 1995, Lyckberg 2001).
One pocket reached 30 m in maximum dimension and another pocket produced over 1 metric ton of beryl with 10 % being of facetting quality.

It is interesting to note that many pegmatite miaroles at Volodarsk had large quantities to several tons of hydrocarbons. Pure hydrocarbon miarolitic pegmatites should maybe be considered as a new pegmatite class with the "type locality" being the Glasberget pegmatite SE of Göteborg on the Swedish west coast (Lyckberg 1981, Lyckberg 1997, Yushkin et al. 2000). It is not known to the author if any hydro carbons have been found in pegmatites in the Viborg massif.

The new find at the Karelia Beryl Mine has been previously described by the author (Lyckberg 2004, Lyckberg 2005), but this account is more extensive for the interest of preserving details of the find and thus some additional data is presented. The author had an opportunity to witness the new pocket and removal of someof this material during 2004 visits to the deposit, which is situated on asmall island in one of the 70,000 Finnish lakes. The exact location is Karelia Beryl Mine, Kännätsalo, Kivi Järvi, Luumäki, Karelia, Finland. Translated from Finnish the names have the following meaning; Kännätsalo (= Drunken Forest), Kivi Järvi (=Stone Lake), Luumäki (= Boneslope (benbacke)). The mine is an open pit mine, located on an island in Lake Kivi Järvi, north of Luumäki village, some 30 kw west of the town of Lappenranta in Karelia. The distance to Finlands south eastern boarder to Russia is only 40 km.

Initial reclaiming

In 2001 the two Finnish friends Jari Vepsalainen and Timo Römkä drove by Luumäki. Jari Vepsalainen, beeing a geological engineer and dimension stone expert with a wast experience in mining dimension stone (granit, labradorite) in Finland, USA and many other parts of the world just happened to mention/say to his long time friend Timo, who was a hobby stone cutter (facettor): (Now the reader has to imagine the Finnish way of speaking, never overexagerating and very calmly). Do you know there is an old mine here? No. Silence .... Lets have a look. They saw the now filled in pit in the forest and decided to check if it was still claimed. This was the ignition to the new gem-producing era.The claim had expired and the team mining in 1982-1995 had given up since no more pocket was really found after their initial discovery.

The two friends Jari and Timo rapidly filed a proper mining claim in October 2002 and started mining. Jari having much experience from granite dimension stone quarrying but not pegmatite gemmining which is quite different and Timo beeing artistically and muscially talented gentleman and an avid collector of butterflies. Later they were joined by a third friend, Jukka Rusanen, who lives very close to the mine itself and added additional economic and marketing strength. The forth member of the team was Timos father, Reimo Armas Römkä, now a famous master Finnish gem cutter.

By searching on the internet, trying to get some more information of gemstones deposits and in particular gem beryl pegmatites, Timo came across a website (Coromoto Mineralsof Gary Feeman, a friend of the author mining the Orchard Quarry and Mt Mica in Maine). On his site Mr. Freeman had posted some hints what to look for in order to find pockets.One of them mentioned was smoky quartz pods or veins running from pockets, a wellknown lead in many pegmatites worldwide. Other pocket leads are bulges in the pegmatite itself, fissure systems (often bulging around miaroles), white quartz veins or even pegmatite stringers going into the country rock, hydrothermal alteration, rusty looking pocket clay etc. Timo followed a geological map by geologist Virkonen where spots and veins of smoky quartz had been marked. The map was laying by his telephone for weeks and months. One day while speaking o the telephone and having a pen, and using the common "while speaking on the telephone drawing method like a child, as Timo put it" he was connecting the smoky quartz pods and veins with a line, and the line pointed to a spot on the eastern contact of the pegmatite, which had yet to be exposed and excavated. Right after having made this important joyful drawing, Timo called Jukka and asked for having an excavator to the spot.

This was arranged within an hour, according to Timo. The team cleared the forest, cleaned of some overburden soil and started digging with a big excavator on a spot where the pegmatite showed a huge chunk of highly altered biotite mica, in parts altered to chlorite and clay right on top of the surface. It was located right at the edge where previous mining had stopped.

The top section of the pocket

This hydrothermally altered mica pod was more than a meter in diameter, originally of a black color but in major parts altered to green, grey and rusty brown. At the dumping of the first scope from the excavator Timo noticed a small 3 cm fragment of gem beryl coming rolling down from the heap, and he now was sure that they would have luck and find some more beryl. This piece is of gem quality and has a yellowish green color. Timo asked the excavator driver not to dig in the clay pod, but by mistake a part came off and the first larger section of three, of gem quality green beryl was found, a section of a really large crystal. This was the very first fine new gem beryl (found on October 5, 2002) and it was given the name **Daisy** (151g, 5.5x4x3.5 cm). The pocket content around Daisy were irregular fragments of black vein smoky quartz, that i.e. no developed crystals. Fairly soon, several more gem beryl crystals were pulled out from the top of the pocket.

A meter below Daisy there was a 4 cm thick white, poorly crystallized albite plate making a lid to the continuation of the pocket. The excavator tried to dig through this white albite, but it was too hard. Luckily, Timo hammered his way through the bottom of the pocket and found an even larger and richer extension. Right under that albite lid a big gem beryl was found and further digging was encouraged.

The middle horizontal giant section of the pocket

Shortly below this lid, a toothlike specimen was found of excellent quality.

This specimen was pictured in mineralien Welt 6/2004 (Ein Neufund phantastischer gruner Edelberylle aus luumaki, Karelien, Finland by P. Lyckberg). Then a huge quantity of larger fragments of semi transparent/translucent beryl was recovered in a very extensive horizontal section of the pocket. Horisontally 1.5 m further into the pocket a large flawless gem crystal, accidentally broken by the excavator into two pieces, was recovered. The smaller of the pieces was named **Vince** (428g, 7x7x5 cm). Vince has irregular channels starting at the bottom of etch marks on the crystal faces reaching a centimeter into the gem crystal. These channel inclusions were also pictured in the above-mentioned article and in La Reign Mineral, No. 62, Mars-April 2005.

In the huge horizontal walk in size but completely filled with cemented rock fragments semi-gemmy crystals of beryl to 9 kg, but most in the 2-4 kg range were found, usually broken in two or more sections. The largest, the **Jumbo** (9 kg), was only partly of faceting quality (gemmy) and semi-gemmy but rather of carving quality. It measured approximately 35 cm in length and over 15 cm in diameter. It was sold at Munchen 2005 to the firm Julius Petch in Idar Oberstein, Germany.

Among the largest gemmy crystals in this section of the pocket was **Jari,** a 2.787 kg (20x11x9 cm crystal) and **Peter** (800+ g, 14.7x6.2x6.7 cm). Jari has one side of gem quality with minute eye visible inclusions. The "back" side being more turbid. Exposed with backlight it shows a very large striated crystal face of excellent color. Peter is a rounded hexagonal prism with a heavily pitched from etching termination, tapering in the other end due to old fracturing during crystallisation (most re crystallised except for small section with fresh break).

Green 2: A 892 g, 8x9x6 cm half crystal section of partly rather intensive green color.

The Tree Foot: A 888 g, 8x8x7 cm tree foot shaped crystal section. Semi-gemmy.

Big Daddy: A 28.5 cm long crystal broken in two sections (1946 g + 2815 g) with a cross section of 10.5x10.5 cm. Total weight of 4.761 kg. Semi-gemmy. This is the largest crystal of true semi-gemmy quality. It has been preserved as a specimen. Heavily striated, doubly terminated.

Small Daddy: Similar to Big Daddy. More tapered in one termination. Also semi-gemmy and broken in two sections (521g + 2315g) In total 20.5 cm tall and 9.5x905 cm in diameter. Total weight 2.838 kg.

Big Mom: A 2.449 kg and 18x9x8 cm semi-gemmy crystal. Gemmy sections on surface, semi-gemmy in most part. Heavily striated, but also showing some etch pitches. Please note here that all complete crystals were given female names and most broken crystals were given male names.

The new beryl pocket was no open pocket as such. Open crawl in pockets at Luumaki has so far only yielded smoky quartz and albite as main components. The lining of the pocket consisted of a 10-20 cm wide dark biotite mica zone, towards the center heavily altered in which small gem crystals of a primarily yellow heliodore color were found. Inside this zone, and especially so in the last vertical section of the pocket, large gem crystals lay in abundance on totally 4 main levels. 1 at the top, one at the bottom and the same in the main horizontal "chamber".

Most of the gem beryls have a contact halo or crust of a Fe-mineral (limonite/goethite). The enclosing matrix of the largest gem beryls is a rather hard rock (solid rock i.e. no clay). The matrix has yet to be studied and analysed properly. Towards the center of the pocket a substantial number of larger beryl crystals were found, only partly gemmy and sometimes covered by a secondary yellowish growth of porous beryl. These make up in total 80 kg of the 110 kg recovered from the Mammoth Green Gem Beryl Pocket (MGGBP). At the bottom and near the end of the horizontal chamber a magnificent crystal named **Alma** was found. Originally it was flawless and doubly terminated but a section was broken of one end in the frensie created of its appearance and fatigue digging the hard pocket by Jukka. Alma is 11-12 cm tall and 5.5-6 cm in diameter, weighs 854-857 gram of superb gem quality and is one of the most magnificent crystals recovered. The termination has a long crevasse of etching with several beautiful hexagonal additional etch marks. Its hexagonal morphology is retained and its sides are striated.

The specimen Alma is pictured together with crystal **Elina** in combination with facetted stones in the above mentioned two mineralogical journals. Elina was found half a meter below Alma, and is of the same exceptional quality with its termination rounded and other end broken millions of years ago in the pocket formation. Elina is a flawless, excellent green colored (620g, 9.2x6.5x6 cm) gem crystal, which stands perfectly on its own. It gives the cleanest impression of all gem crystals recovered. It was collected by Timo, who could feel the rounded termination in the rusty ice cold water in its vertical position on the pocket floor.

Other important crystals recovered here were:
Green: A 632g, 10x5.5x6 cm crystal section of a strong more dark lime green color and showing some sharp hexagonal growth.

Big one: A 3.475 kg, 23x11x8.5 cm, almost gemmy, large crystal, unbroken, partly with a secondary layer of more porous beryl on its back side.

Etched: A 1452 g, 11x11x7 cm, large stubby, gemmy crystal with interesting etching, especially at termination.

David: A true gem quality TN crystal of excellent color and rounded striations.

Fist: A 109-111 g fistshaped gem crystal 6x4.5x3 cm in size.

Heliodore: A 139 g (7x4.5x3.5 cm) crystal of very fine golden color. Heavily etched and rounded.

The pocket was dug vertically for 4 meters, horizontally for 4.5 meters. Here the pocket turned to a vertical, extremely productive, narrow shaft.

The bottom gem rich section of the pocket mined April 18 2004 - May 15 2004

The richest and most exciting gem beryl congregation and almost equal in quality to the Alma and Elina was yet to come. The pocket was here vertical and narrower and barely a meter in diameter. In the spring of 2004 the author was in constant contact with Timo on the telephone and via internet. Daily reports of mining progress were made, and a revisit to the site was done.

Only 30 cm from the bottom there was a second level with large gem crystals, some of them among the very finest found. Timo carefully using his small chisel heard the ringing of gem crystals wherever he put it in the bottom (under the rusty water) so he did not know where he could start to dig, in order to extract the crystals intact. It shall be said that the pumping of rusty water was from the bottom of the pocket all the time and thus the visibility was very poor. Soon the majority of the finest green gem crystals from this exceptional pocketsaw the light of day here.

Kekkonen (or the Finnish Winter War) is the largest complete gem (faceting grade) crystal which has been recovered. It lay next to **Timo** (or broken dreams), **Jukkas Beer Bottle, Erika** and **Linnea**. These 5 crystals all belong to the very finest from the pocket and came out within a very small area. Erika and Jukkas beer bottle were found laying horizontally right next to each other with just a few centimeters separating the two.

Kekkonen (also named **the Finish Winter War**) (1.602 kg, 22x7.5x5.8 cm), is a somewhat flattened but complete and doubly terminated crystal and of gem quality with minor smaller inclusions. Excellent color. Mr. Kekkonen was a man and president of Finland. Still it was named after him and the long war the Finnish people fought against the Russian invasion of parts of Karelia during World War 2.

Jukkas beer bottle (512 g, 15.7x5.5x4.5 cm) has very rounded faces, a smooth surface with strong etch mark pitches more typical of some of the Volodarsk beryls. (Elina also have a bit more pronounced such marks). Its shape resembling a beer bottle and found by Jukka it instantly got its name. It has a several cm long shard broken off the back side of the "bottle neck" and also one piece on the front is missing. Despite these recent breaks it is a magnificent gem crystal from Europe.

Please note that presumably etching occurred due to alkaline solutions (from feldspar breakdown) present after crystallisation.

Timo (also named **broken dreams**) (1.214 kg, 16.5x7x5.4 cm) is a fantastic gem crystal of excellent green color and breathtaking transparency.

Had it been complete it may have been the most impressive crystal in the pocket. A few centimetre below its termination there is an etch ring, typical from many beryl localities in the world and on the back side a few cm shard was broken off a long time ago. The bottom section has fresh breakage from the mining work and reveals it flawless interior.

Erika (822 g, 14.5x6x6 cm) is an excellent doubly terminated gem crystal of very fine color, standing perfectly on one termination, the other thicker end is pointed (from etching). It was the first fine crystal that was sold, and at that time no other was available.

Linnea (106 g, 10.5x3x3 cm) is a a superb, slender, doubly terminated, tapering crystal. The largest and finest such found.

Because of the long winter with thick snow and cold temperatures, the mining season starts in late April or beginning of May and continues until October or exceptionally until mid December (2005). This giant gem beryl pocket was thus worked under some secrecy for 1.5 years before the pocket was finally emptied in May 2004 and the first articles were issued to MineralienWelt, Gems and Gemmology and La Reigne Mineraux. Every day, after working the pocket for some hours, the pocket was flooded with several meter of water as to hinder any high graders destroying or stealing any crystals. The groundwater is very near the surface and thus the pumps are continuously run during pocket digging, keeping the freezing cold water to a minimum. Pumps were removed from site, and, as one of the mine owners lives right next door, there still was every day after work someone watching the site.

General geological observations at Karelia Beryl mine

The Karelia Beryl Mine deposit near Luumäki is in some respect similar in appearance to some of the larger multiple pocket pegmatites at Volodarsk. The latter usually have a few pockets, and one or several quartz cores. The Luumäki deposit has one large quartz core and several smaller ones. The main quartz core has multiple pockets along its sides and some in the central parts up to a meter or more. There are rumours of a walk in pocket in the 80 s.

The largest pocket found during recent activity was a somewhat flattened 4x3x1 m high chamber under a local quartz core with a doomed ceiling. It yielded large smoky quartz crystals (morion) some with Tessiner habitus and 6-35 cm in length, 2-20 cm in diameter laying loose within the pocket. The pocket was also partly lined with a late stage morion quartz layer with a few mm thick, red color on the pocket surface, some of this covered with a matt of goethite crystals, usually around 5 mm in length. The floor was covered with large plates of albite to 0.7 m of slightly convex nature. These pockets typically yield only quartz or smoky quartz, some of it suitable for collection material or cutting.

Within only a couple of meters from this pocket large white intergrowths of beryl occurred frozen in feldspar and right next to them excellent thin hexagonal muscovite crystal 5-10 mm in diameter on open fissures. There was no beryl at all noted within this pocket. A few small gem beryls were found in a couple of centimetre diameter tube-like pocket directly under the main quartz core on its east side in the back wall of the quarry. Several pockets nearby had no beryl.

This new find at Karelia Beryl Mine differs from earlier find in that it is not associated with any primary non gem quality mineralisation so far encountered frozen in the pegmatite although such a zone could possibly have been existing above the new pocket and having since long been eroded away. Larger gem quality beryls are sometimes overgrown with a secondary impure paler yellowish beryl of a porous nature.

Further here are unconfirmed reports of a find of loose gem beryl from the moraine only a kilometer to the south of the mine during house construction work (visit May 2004).

During late autumn of 2004, and especially during spring and summer 2005, additional field studies revealed a half meter thick and around 20 m extensive (exposed) heavily hydrothermally altered zone in the rapakivi granite just overlaying the pocket carrying section of the pegmatite. This zone had not been visible as clearly due to mud cover from mining and winter water pond. It is clear that late stage solutions in this section of the vein has altered the overlying rapakivi granite significantly. Due to a language related misunderstanding of direction of original extension of the upper part of the pocket, it was believed that the Be-mineralization was controlled to the crosscutting thin fractures cutting the rapakivi granite. Studies in the field and of older photographs taken during initial mining reveal the true extent of the gem beryl carrying pocket, its 3-dimensional geometry and its mineralisations.

It shall also here be noted that the entire pegmatite is heavily altered by hydrothermal late stage solutions in its northern 1/3, that is in a more than 20 m wide zone extending from the contact to the enclosing rapakivigranite next to the green gem beryl pocket across the entire pegmatite vein to the road on the quarry's west side. This part of the vein will be mined out in the coming seasons, and the pegmatite seem to dip under the rapakivi granite to the east, so there are prospects for further pockets below and beside the green gem beryl pocket.

Accessory minerals from the pegmatite
Except for beryl and quartz, the other minerals are more of scientific interest rather than as visually attractive specimens. The Volodarsk pegmatites have been studied in much detail, and in total 103 valid species had been determined until 1995 (Dr. Panchenko, personal communication 1995).

At the Karelia Beryl mine the following minerals have been noted so far:
Topaz: It is found during the first period of mining as large white crude crystals to 15-20 cm (visit 1995). Only smaller topazes are clear, and their color ranges from colorless to light blue and even pale pink. Topaz also occurs, as noted before, as fractured masses under the main quartz core. The largest such mass observer in 2004 measured approximately 30x10-15 cm. It showed plane faces in sections.

Quartz: As crystals up to several dm and many kg in weight. One large 3-4 m pocket was opened in August 2004 and yielding many dozen, sharp, black morion (smoky quartz) crystals to 35 cm. Quarz occurs as large cores within the pegmatite and as a component in all zones (the pegmatite has a very well developed graphic zone, an intermediate zone, and a blocky zone). The contact zone is commonly 10-20 cm wide and made up of a multitude of pockets with poorly developed quartz crystals and K-spar.
Pockets within the core yielded light smoky quartz crystals lining the walls. Large black morion crystals grew from the quartz cap down towards the pocket center/bottom. They are found loose in the pocket, and are sharp and well terminated, often of tessiner habitus to 35 cm.
Second generation quarz consisted of some red crystalline shards, often with a layer of a goethite mineral commonly 3-8 mm in length and covering larger surfaces.

Beryll: Large, sharp non-gem primary beryl crystals to 30 cm in diameter and 1 m length frozen in pegmatite was reported by Risto Pitkänen (1991 and personal communication1990) in the northwest corner of the pegmatite, next to the road, but lack in much of the southern half of the pegmatite. Their color being primarily in yellow tones. Some beryl show alteration i.e. probably fine grained bertrandite.

Pocket beryl: In pockets semi-gemmy crystals to 15 cm in diameter and 30 cm in length are found. Gem beryl colors range from strong green, to almost rare lime green (semi-gemmy). More common is yellowish green and in rare cases pure yellow golden color ("heliodore" colored). Completely gemmy crystals in several cases reach 0.6-1.6 kg and 10- 22 cm in length. These larger stones exhibited a fine green to yellowish green color. Crystals typically showed rounded terminations, striated surfaces and were etched, though most retained some of their hexagonal shapes.
In 2004 most of these exceptional crystals were saved in their natural state by selling them to private collectors in Western Europe.

The largest beryl from pocket as noted earlier had a weight of 9 kg. Several thousand carats of cut stones could have been fashioned from the lot of larger crystals, but most of them were instead preserved as specimens. Karelia gem beryl must surely be among the finest gem specimens ever found in Western Europe and could stand among the world's best green, etched gem beryl.

One 3 centimeter long golden beryl from the locality was recently studied, and was shown to have dozens of parallel channels running perpendicular to the *c*-axis of the crystal. These channels were filled with rusty hypergene clay minerals. Inclusions of gas, liquid and minerals occur in abundance in semi gemmy crystals. There are also channel tubes along the c-axis in some crystals, but also dislocation channel tubes with an angle from 5 to 30 degrees to the c-axis or completely irregular. Tubes often occur in parallel bundles, but may be completely irregular with an inner crystal structure starting from the surface at the bottom of etched pitches and extending for up to 10 mm into the crystal.

Some crystal sections show chatoyance, and would produce a cats eye effect if cut properly with correct orientation. The effect is probably due to somewhat rapid growth creating numerous minute parallel growth tubes.

The largest cut beryl from Karelia was faceted in Finland. In fact, Finnish master faceter Reimo Armas Römkä (father of Timo) has cut a total of 90 to 100 large (25-50 carat) stones. Reimo being a weapons smith all his life and having an excellent hand and eye for detail. Its the forth man in the team to link to the fancy gem consumer. Armo has also been very active in the mine, digging and mocking the pocket, sorting and cleaning pocket material.

Over the years, about 11 000 round brilliants of 10 millimeters in diameter have been cut in China. A few larger carvings were also made. Almost all of the cut stones were sold on the Finnish domestic market and in fact the demand is much bigger than the production.
The search of beryls in glacial float/moraine has started on selected spots.

Albite: Primarily as crude shards usually up to 5-10 cm in pockets.
Bertrandite: In small crystals.
Biotite: As sharp crystals to 10-25 cm in the up to 4 m wide K-feldspar zone enclosing the large quartz cores. Mostly heavily altered (chlorite, vermiculite) showing green and rusty red colors near and in pockets. Lining and filling pockets, and contains etched, yellow gem beryl crystals and nodules. The intermediate zone contains biotite in sword-like crystals and hexagonal plates. No analyse has yet been done to distinguish the two types mineralogically.
Calcite: Rare.
Chlorite: Very common in pockets.
Columbite group minerals: Noted around one gem beryl carrying pocket at the base of 1 m large primary beryl crystals frozen in quartz 1986.
Euxenite: Noted in 1986 around one gem beryl carrying pocket at the base of 1 m large, primary beryl crystal frozen in quartz.
Fluorite: Rare.
Goethite: Not analysed. As fine carpets of fibers growing on red colored quartz in smoky quartz-albite cavities under quartz cores. Crystals typically 5-8 mm in length. As fine-grained "coloring agent" as coating and matrix of pocket material.
Gypsum: Rare, secondary mineralization.
Hematite: As inclusions in quartz. As fine-grained "coloring agent" as coating and matrix of pocket material.
Illite: In cavities and fissure fillings. As a weathering product of feldspars within the pegmatite and as meter thick covers after weathering of the rapakivi granite itself.
Kaolinite: In pockets and fissure fillings. As a wethering product of feldspars within the pegmatite and as meter thick covers after weathering of the rapakiwi granite itself.

Margarite: Rare.
Microcline: As occasional large crystals. One such crystal from the green gem beryl pocket measured 40 cm across. A complex multiple twin 12 cm in diameter was recoverd from the same pocket. As veinlets, broken shards and plates dividing the green gem beryl pocket.
Microlite-pyrochlore: Noted in 1986 around one gem beryl carrying pocket at the base of 1 m large primary beryl crystals frozen in quartz.
Monazite–Ce: Noted in 1986 around one gem beryl carrying pocket at the base of 1 m large primary beryl crystals frozen in quartz.
Muscovite: As small, hexagonal free growing crystals to one centimetre in fissures near beryl and smoky quartz and K-feldspar in the blocky zone around quartz cores of the pegmatite. Also frozen in the pegmatite.
Smektite: In cavities and fissure fillings. As a weathering product of feldspars within the pegmatite and as meter thick covers after weathering of the rapakivi granite itself.
Vermiculite: Very common in pockets. Fine grained or as large plates of altered biotite along pocket walls. Also occurs in fissures.

Location, geometry, type and geochemistry leads of the green gem beryl pocket
The location of this particular cavity was unusual in that it was found very close to the only hanging wall. In most parts only half a meter to one meter in such a big pegmatite. It is not as clearly assymetric vertically as the Volodarsk chamber pegmatites except for the Biotite cap where the Volodarsk pegmatites usually have a quartz cap. The pocket was surrounded by a zone of intense hydrothermal reworking, which in this aspect corresponds to Volodarsk type 2 miarolitic pegmatites (Zagorsky 1999). Pockets in Volodarsk have a clear tendency to have a similar shape as the overlying quartz cap (Zagorsky 1999). The longer the quartz caps, the longer and flatter are cavities. More complicated shape of miaroles were observed in Volodarsk in large bodies with an irregular shaped quartz core.

At Volodarsk there are positive F-haloes around crystal bearing pegmatites, which may also be used in Finland as one prospecting criteria (Oganesyan and Kolbin 1969, Zagorsky 1999). Fluorine concentrations of 4600 to 5400 ppm have been measured at Volodarsk (Stavrov and Bykova 1961, Zagorsky 1999). Yusupov (1974) made a study of 87 pegmatites within 11 granitic massifs in the former Soviet union states (Russia, Kazachstan) from which he concluded that the optimum conditions for forming pockets with quartz crystals in pegmatites (for piezo electric use) were in miarolitic cavities with a 0.9-1.3% average content of fluorine.

Halite may take a volume of 20-25 % in inclusions in quartz from Volodarsk, which also contains sylvite and $FeCl_2 \cdot H_2O$ (Lazarenko et al.1973). Zagorsky (1999) suggested that CO_2 played an important role in the formation of many types of miarolitic pegmatites. It has already been noted previously the hydrocarbon bearing miarolitic pegmatite at Glasberget and some of the Volodarsk.

In the Volodarsk pegmatites, the completely differentiated and productive pegmatites have a 3 times higher Li content than the weakly differentiated and unproductive ones (116 and 40 ppm, respectively). In booth types the Li abundance increase from the marginal zones (periphery) toward the center, but the tendency is clearer in productive pegmatites.
The lower parts of the pegmatites also have a higher Li content than the upper parts (Pavlishin and Vovk 1971). The Rb and Cs amount is 2 to 3 times higher in the central zones than in the peripheral parts, and may reach 800 ppm.

Gas comprises 80-90 volume-% in primary-secondary fluid inclusions with a polymineral solid phase. According to Lazarenko (1973) bulk gas analyses and analyses of water extractions in Volodarsk samples showed that CO_2 increases from 3-8 % to 70-80 %, nitrogen and hydrogen decrease from 85-80 % to 13-20 % and 17-22 % to 2-4 % respectively (gas phase inclusions in granite minerals) from the granite towards the pegmatite (Lazarenko 1973). Primary melt inclusions in topaz from Volodarsk pegmatites consist of 70 % volume solid phases co-existing with aqueous fluids according to Tsareva et al. 1992 and Kovalenko et al. 1996. The Volodarsk pegmatites formed at 1.1-0.2 kbar (Lazarenko et al. 1973) or 1.4-<0.1 kbar (Bazarov 1968). The H_2O/CO_2 ratio (mass quantities) was studied by Raman spectroscopic analyses of Volodarsk quartz samples by (Bakumenko and Smirnov 1992) and was found to be 3:1. Carbon isotopic composition of CO_2 from inclusions of different age of quartz at Volodarsk pegmatites matches the isotopic composition of magmatic carbon and is clearly different from exogenic carbon. Heavy carbon ^{13}C increases, while the temperature of pegmatite formation decreases (Mamchur et al. 1968, Lazarenko et al. 1973). Based on the results of carbon isotope analyses they concluded that deep fluids had participated in the formation of pegmatites along with granitic magma fluids (Mamchur et al. 1974). An inflow of deep fluids may explain high $^3He/^4He$ ratios at Volodarsk (Tolstihin et al. 1974).

The beryls were found at several levels even at the very top right under the biotite cap which is unknown for any of the Volodarsk chamber pegmatites. The new pocket green gem beryl is shaped like a straightened fat bellied S laying down on its back as viewed from the core of the pegmatite towards the south east. The first part (top of the S) is a 2 m vertical section, then comes a 4 m horizontal extension about 2 meter wide and heigh, and again a vertical, gem rich part. The diameter of the straightened S shaped tube was approximately 1 meter in its narrowest part and 2 meter in its widest. The total horizontal extension approximately 4.5 meter and vertical total extension of 4 m. Most of the gem beryl was found within 10-25 centimeters of the walls of the pocket. The beryl occurred in association with 5 to 15 centimeter wide blades of mica, with crude albite. The pocket rubble included broken shards of microcline and rarely quartz. It can be noted that the pocket was separated into several zones by horizontal albite plates from wall to wall which could have made miners believe that the pocket was finished, should they not persistently have worked their way down through the plate and noted that the pocket mineralization continued further.

There were three principal layers of large gem beryls; one near the top, the second near the bottom of the main horizontal pocket, and the third only 30 cm up from the bottom of the last vertical narrow pocket section. The main chamber (horizontal) produced by far the largest quantity and size of gem beryl, but most of them were semi-gemmy. Their color is often excellent green, transparency from translucent to really gemmy sections. They are often turbid, i.e. have clouds of small fluid and gas inclusions. Between these layers were found broken translucent beryl crystals of cabochon- and carving-quality. The beryl ranged from light yellow to deep golden yellow, and from green yellow to green. The translucent were typically broken in sections reaching 10-15 cm in diameter; some areas showed chatoyance. They are exceptional for gem quality specimens of beryl from the EU, and some were used for carvings, although most saved in their natural state.

In the green gem pocket a 15-30 cm thick lining of heavily altered mica containing etched golden beryls is found around the pocket. The interior was compact, solid, only the feldspars having numerous micro cavities, the beryls interspersed within etched feldspars, albite shards, veins and plates dividing the pocket and crystals to 6 cm, mica-clay, smoky quartz as dark black (morion) broken shards. During visits to the deposit in 2004 and 2005 the author studied the pegmatite and surrounding rapakivigranite. A geochemical investigation is ongoing to determine more precise conditions of formation, but it seems probable that the gem beryllium mineralisations are cogenetic with fissure formation and thus the crystallisation (contraction fissures?) of the rapakivi granite and the pegmatite bodies within it.

These large stones are of a fine green to yellowish green color, rather distinct from the Ukrainian material both by color and morphology. Crystals are typically etched, but have retained their hexagonal shape, heads are rounded and surfaces typically striated and showing also etch marks described and pictured in Lahti & Kinnunen (1993). It would have been possible to facet stones to several thousand carats, but the largest fine gem crystals have been sold to collectors in order to preserve their natural beauty. These are the finest gem specimens found in Western Europe during milleniums of mining in tens of thousands of mines, and are second to none in quality from anywhere in the world. The location of this new, large cavity in the pegmatite was unusual, in that it was found only 20-40 cm from the hanging wall together with crystals of mica (typically 5-15 cm) and crude albite (1-8 cm), as well as pocket rubble consisting of fragments of microcline and rare quartz.

Thus its position within the pegmatite body is very different from anything the author have seen reported, published or seen on site in Volodarsk, or heard from geologists there. Beryl occurred also along the walls at the bottom of pockets at Volodarsk. The beryl crystals were typically etched, similar to some of those produced from Ukrainian pegmatites in the 1980's-90's, but are often distinguishable by their general appearance and color. Inclusions in this new material is similar to that descibed by Lahti & Kinnunen. (1993).

A small, 3 cm golden yellow heliodore beryl studied in 2004 had dozens of paralell channels/tubes along the c-axis running through most of the stone and beeing filled by rusty hypergene clay minerals. Similar tubes were found in a large 2 kg crystal from Karelia, as well as in a 12x2 cm Volodarsk gem rystal.

Of the first studied samples found in 2004 none had the for Ukrainian beryl typical clouds of thin inclusions which are easily seen with a light passing through the c-axis and viewed in the same direction. Later studies of large translucent Karelian beryl crystals reveiled inclusions similar to the Volodarsk material. Note that only a few of the Ukrainian rough have this typical morphology and color, which may make them rather hard to distinguish for some people. The larger beryl has been faceted in Finland. 90-100 large (25-50 carat each) stones have been facetted by Finnish master faceter Reimo Armas Römkä. Most stones are light yellow. In addition about 11,000 round brilliants of 10 mm in diameter have been cut abroad (in China). Earlier the stones were cut in Idar Oberstein. Most stones have been sold on the domestic market. Many of these have been sold for a symbolic sum of money (10-50€ each) in comparacy to their rarity and cost of finding them.

Luckily only a few large gem crystals which had deserved to be preserved were cut. The author is happy to have been able to convince the miners of the quality and value of all the gem crystals, despite minimal offerings to the company at the Tucson show and elsewhere. This almost made the majority of the crystals end up as cut stones.

Future prospects

Mining is planned to continue in the area of the largest gem pocket since the overlaying rapakivi granite here shows, in half a meter thick horizontal layer next to the pegmatite, significant signs over at least 20 m length of having been affected by nearby hydrothermal activity.

This author finds it very important to properly try to recognise the involved persons contributions. This small mining, extraction and marketing team has truly been very successful. *Jari* being the long time granite mining expert was an obvious main pillar for success in a mining project like this. His knowledge in many speciality matters, reading the granite, his expertise in the mining process and of equipment use and repairs was vital. *Jukka* joined the team just a bit later, but provided some additional financial back up, excellent marketing and promotion skills, since being director of a transport company and having a petrol station and other business. *Timo*, calling himself the "mine mule" since he spent a lot of time in the mine extracting crystals However, all three have been heavily involved in the mining process in different stages. Last, but not the least, *Reimo Armas Römkä* (father of Timo), who has also spent lots of time in the mine, especially initially before the other "boys" tied him to the faceting machine.

Timo must be recognised as the one person who made all this happen, the find of the exceptional green gem pocket at the Karelia Beryl Mine. He was not only the one studying the geological map, drawing the line and connecting smoky quartz pods, but moreover was the one who recognised the pocket zone without any previous experience or formal training. Being a real renaissance man, musically and artistically most talented, and being an avid butterfly expert and collector.

Men like these are the ones who do not seek attention, but really deserve every ones admiration for their humble attitude, their exceptional capabilities and kindness.The mineralogical community owe much gratitude to these four brave Finnish men from Karelia, who by their work have made one of the most significant finds of gem mineral specimens in Europe's 2000 year mining history.

We also owe a big gratitude for their understanding wives and families, who during the lovely summer months not always have seen so much of their husbands as they would have liked to (I hope). It is always a difficult balance between success and disaster, and much thanks to strong Finnish women it was the former.

Thanks to their trust and bravity, the majority of these wonders of mother Nature have now been saved in collections in Europe.

The author wish to especially thank the three miners Timo, Jari and Jukka, Armo and their families for excellent cooperation and good times.

It is suggested here that when mining is finished at the Karelia beryl mine, the local administration together with the Finnish Geological Survey, who poses immense knowledge in this subject, should use their influence to have this site saved in the open air and not having to be filled and covered by soil. This is a unique object for future generations to visit and study.

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Fig 1. In the past three years, mining activities have resumed at the classic gem beryl pegmatite near Luumäki, Finland. Heavy machinery is used to reach the gem-bearing zones, which are then carefully mined by hand to avoid damaging the crystals. Photo P. Lyckberg. [DSCN5950]

Fig. 2. Peter Lyckberg with two 15 cm long, gemmy, etched beryl crystals ("Erika" and "Jukkas Beer Bottle") found in the Karelia Beryl Mine in May 2004.