Stone Materials of the Necropoleis Monuments

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Abstract

Based on the results of many years of monitoring, the unique stone material of tombstones in the historical Necropoleis of the Museum of City Sculpture is described, represented by marbles, limestones, granites and other rocks. The most probable locations of deposits of the used decorative facing stone were in most cases identified with the help of archival data and other literature. It is shown that the diversity of stone in the Necropoleis is as great as in downtown St. Petersburg. There are also unique monuments (to N.A. Rimsky Korsakov, I.R. Tarkhanov, etc.), whose stone material has not yet been found elsewhere. The stone was delivered mainly from Italy and the vicinity of St. Petersburg (from the territories of the present Leningrad region, Karelia and Finland).

Keywords

Historical Necropoleis • Artistic gravestones
Tombstones • Marble • Limestone • Granite
Deposits of decorative facing stone

The collection of artistic gravestones in the historical Necropoleis of the Museum of Urban Sculpture is a unique collection of decorative and facing stone: marbles, limestones, granites and a number of other rocks.

The first description of marble of the Necropoleis tombstones was performed by N.B. Abakumova in 1975 (Abakumova 1975). A systematic study of the stone material of the museum Necropoleis has been under way since 1998 (Mironova 2000; Lepeshkina 2004; Esipova 2006, Kuruleva et al. 2012; Kompleksnyi monitoring 2011, 2013). Based on the results obtained, the diagnosis of the stone is made and, in most cases, a reasoned conclusion is given about the site where it was quarried.

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2.1 Marble

Memorials of marble are, undoubtedly, the treasures of the Necropoleis. The most common is *milky white homogeneous fine- and medium-grained (grain size < 1 mm) marble* (Fig. 2.1). Such marble often has a cloudy pattern (indistinct spots and/or bands) (Fig. 2.2), as, for example, on the gravestones of A.N. and A.P. Mordvinovs, Y.G. Bryansky, M.P. and A.M. Kolychevs, E.A. Rantsova. White homogeneous marble was widely used for manufacturing various ornamental parts of monuments: sculptures, reliefs, vase lamps, urns. Monuments made of this stone are often characterized by a complex shape and have a unique artistic value. These include the tombstones of A.I. Kosikovsky (sculptor P. Catozzi), E.A. and V.N. Kochubeys (sculptor A. Costoli), A.Y. Okhotnikov (sculptor F. Thibaut), Z.A. Khitrovo (sculptor P. Triscorni) and others.

The results of field observations and laboratory studies (polarization microscopy, X-ray phase analysis) showed that the rock is composed of isometric grains of carbonates (calcite, less often together with dolomite), 0.05–1.00 mm (mostly 0.3–0.6 mm) in size (Fig. 2.3). Mosaic structure of the marble is typical for rocks of uniform composition and formation conditions. Quartz is found among impurity minerals.

The mineralogical and petrographic characteristics of the marble in question and the archives of the Museum of Urban Sculpture (Timofeev et al. 2006) indicate that this is the famous Italian Carrara marble, called Statuario (statuary) marble (Shuman 1986). The Carrara marble is a collective name for marbles in northern Italy, near the town of Carrara in the province of Tuscany, at the foot of the Apuan Alps

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Fig. 2.1 Monument to A.N. Esipova from white Italian marble in the Necropolis of Masters of Arts

(Fig. 2.4). It was quarried in the days of ancient Rome and is still quarried to the present day. The Carrara marble has served as a material for many masterpieces of world sculpture. In St. Petersburg, sculptures in the Summer Garden were made of this marble (now they are replaced with replicas) and other sculptural compositions (Bulakh and Abakumova 1987, 1993).

Light gray (sometimes pearlescent) homogeneous fine- and medium-grained marble, often with indistinct banding can also be found in the Necropoleis (Figs. 2.5a, 2.6). Marble was used, mainly, for pedestals and decorative elements (tombstones of N. Buturlin, P.Ya. Dubyansky, A.K. Imeretinsky, M.M. Golitsyn). The P.V. Sheremetev's funerary memorial is entirely made of this marble (Fig. 2.6).

The results of laboratory studies of the marble of A. Imeretinsky's gravestone showed that in terms of its mineralogical and petrographic characteristics, light gray homogeneous marble is very close to the Carrara white marble described above. The rock is composed of isometric calcite grains 0.1–0.9 mm in size, with the size of 0.3–0.6 mm prevailing. Coal dust is registered at the grains boundaries (Fig. 2.7).

Visually the light gray marble from the museum Necropoleis is very similar to the bardiglio marble from the Carrara Quarries, which was mined near Serravezza (Tuscany, Italy) (Fig. 2.5b). This marble was used in the first restoration of the outer facing of the walls of St. Isaac's Cathedral (1870–1890) (Bulakh and Abakumova 1987).

Quite often in the museum Necropoleis monuments of *white, mostly coarse-grained* (*predominant grain size* > 1 mm) *marble* can be found (Fig. 2.8).

Such marble was used in the manufacture of semi-columns and supports for them, large vase lamps, urns. It is from this marble that the monuments to A.I. Jendre, A.N., A.P. and A.K. Mordvinovs, S.A. Tishevsky, E.I. Neklyudova are carved.

The results of field observations and laboratory studies of marble have shown that this is an inequigranular rock composed of calcite, or calcite and dolomite grains (dolomite

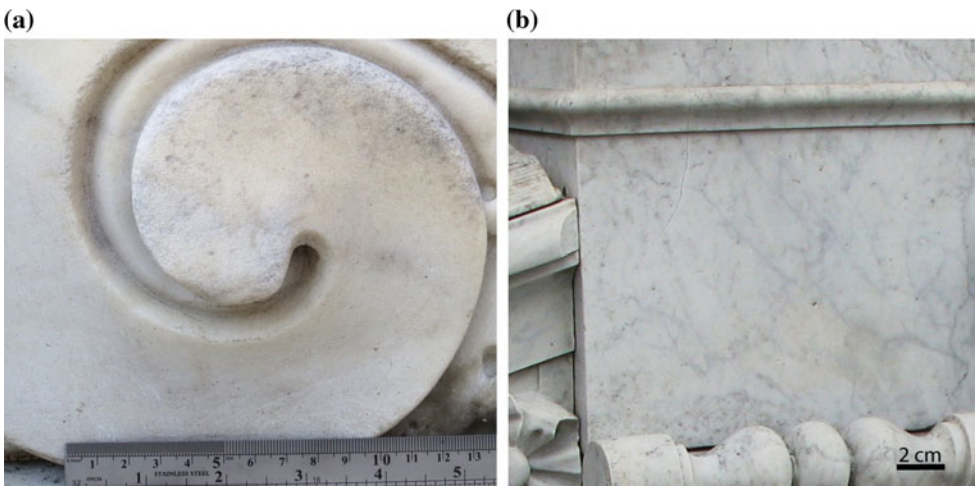

Fig. 2.2 White homogeneous marble with a cloud pattern. Monuments: **a** to E.A. Rantsova, **b** to A.N. and A.P. Mordvinov (Necropolis of the 18th century)

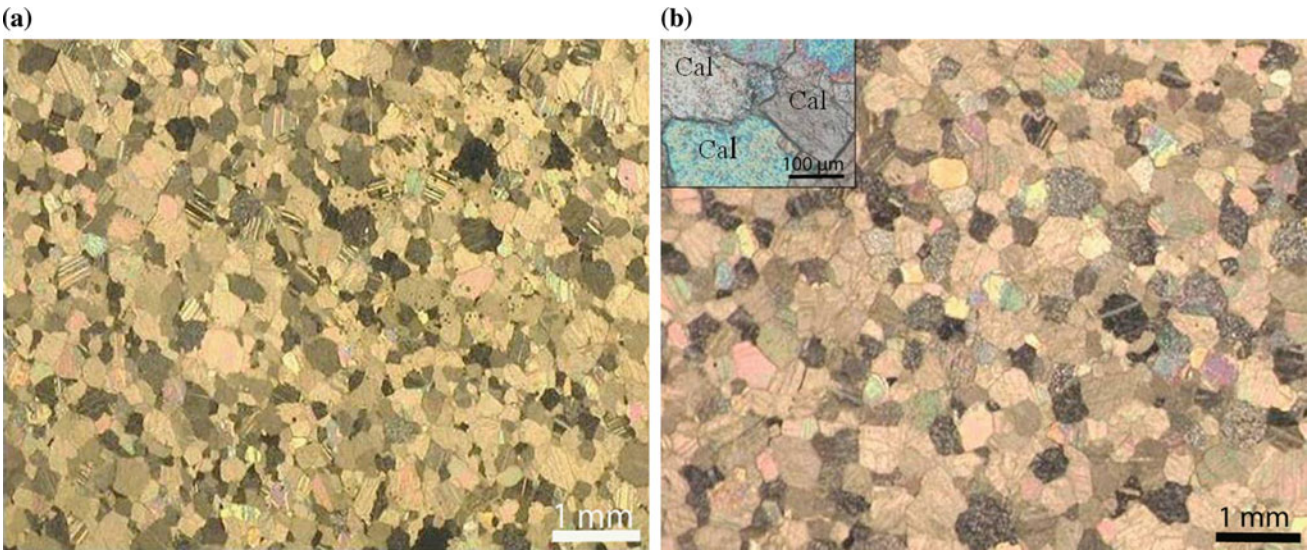

Fig. 2.3 Light microscope images (XPL) of the thin sections of white small- and medium-grained calcite marble: **a** the monument to F.V. Zakurin (Necropolis of the XVIII century), **b** Carrara deposit (Italy). Here and below: XPL—cross—polarized light, Cal—calcite

Fig. 2.4 Carrara quarries (https://limanskaia.tourister.ru/excursions/6436)

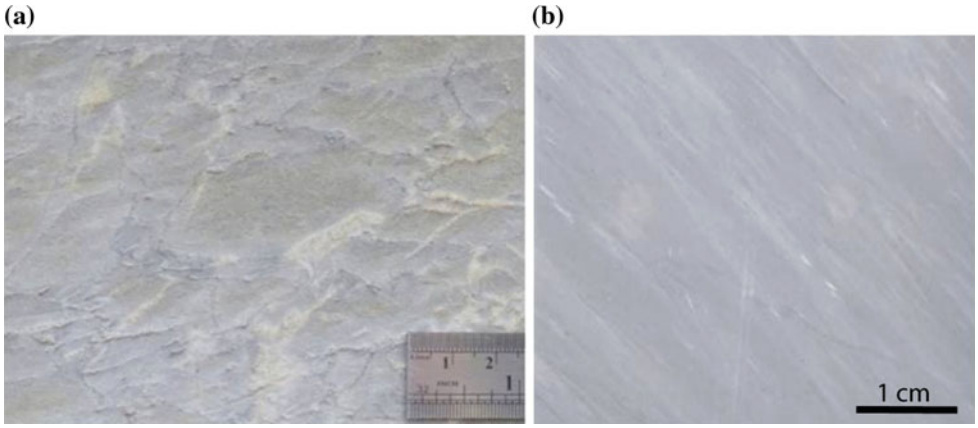

Fig. 2.5 Light gray homogeneous marble: **a** the monument to P.V. Sheremetev, **b** "bardiglio" from the Carrara deposit, Italy

Fig. 2.6 Monument to P. Sheremetev from light gray homogeneous marble in the Necropolis of the 18th century

Fig. 2.7 Light microscope image (PPL) of the thin section of light gray homogeneous calcite marble (the monument to A.K. Imeretinsky) Here and below: PPL—plane—polarized light

in a subordinate amount). The grain sizes vary from 0.1 to 7 mm. Grains larger than 1 mm predominate (Figs. 2.8, 2.9). Quartz is found among impurity minerals.

Visually, this rock is very similar to the marble used by A. Rinaldi in the construction of the Marble Palace in St. Petersburg (the decor of the windows, the main staircase and the marble hall).

It is known that marble for the Marble Palace was brought from the Urals (Ukhnalev 2002). The mineralogical and petrographic studies of this marble made by the experts of the *Spetsproektrestavratsiya* R&D Institute (Mamonov and Haryuzov 2003) showed that the stone was most likely brought from the quarry of the State Polevskoy factory located in the present Sverdlovsk Region. Thus, the Ural marble from this field may have been used in the manufacture of the Necropolis monuments.

The next most common after the white homogeneous Italian marble is *gray banded, heterogeneous inequigranular marble*. Dark gray and light gray bands vary considerably in width and can be very contrasting (Fig. 2.10). Often there are agglomerates of green grains, which can form bands and spots (Fig. 2.11). Such marble was widely used for monuments and individual details (semicolumns, pedestals, vase lamps). Gravestones of S.K. Münnich, E.A. Demidova, E.M. Konstantinova, P.P. Bakunin, E.A. Rummel were made of it.

The results of field observations and laboratory studies have shown that in addition to carbonates (calcite and dolomite occurring in different ratios), there are quartz,

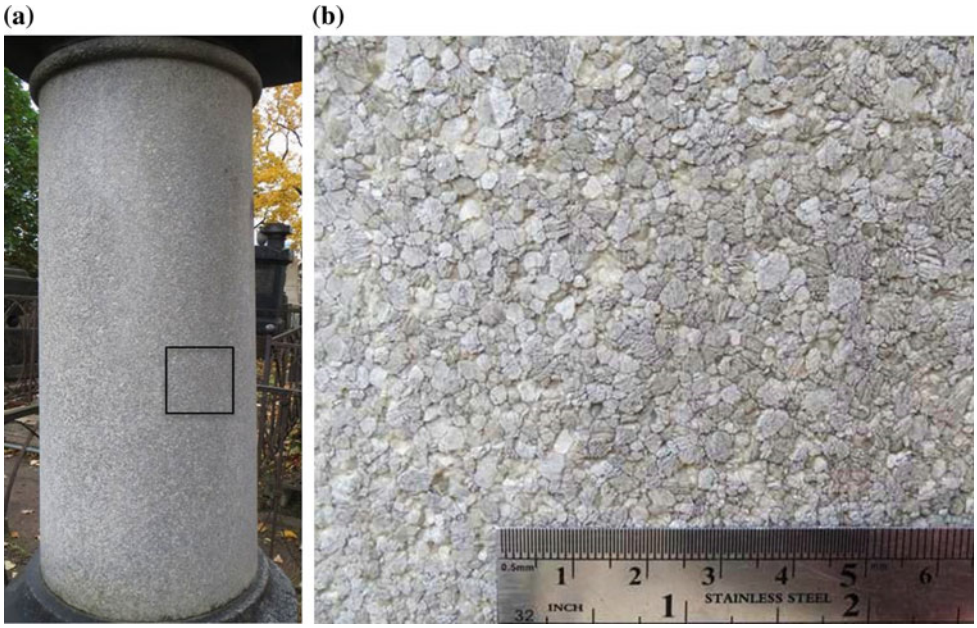

Fig. 2.8 Pillar of white, mostly coarse-grained marble of the monument to A.I. Jendre (Necropolis of the 18th century): **a** general view, **b** fragment of the rock. (field 1 in Fig. 2.8**a**)

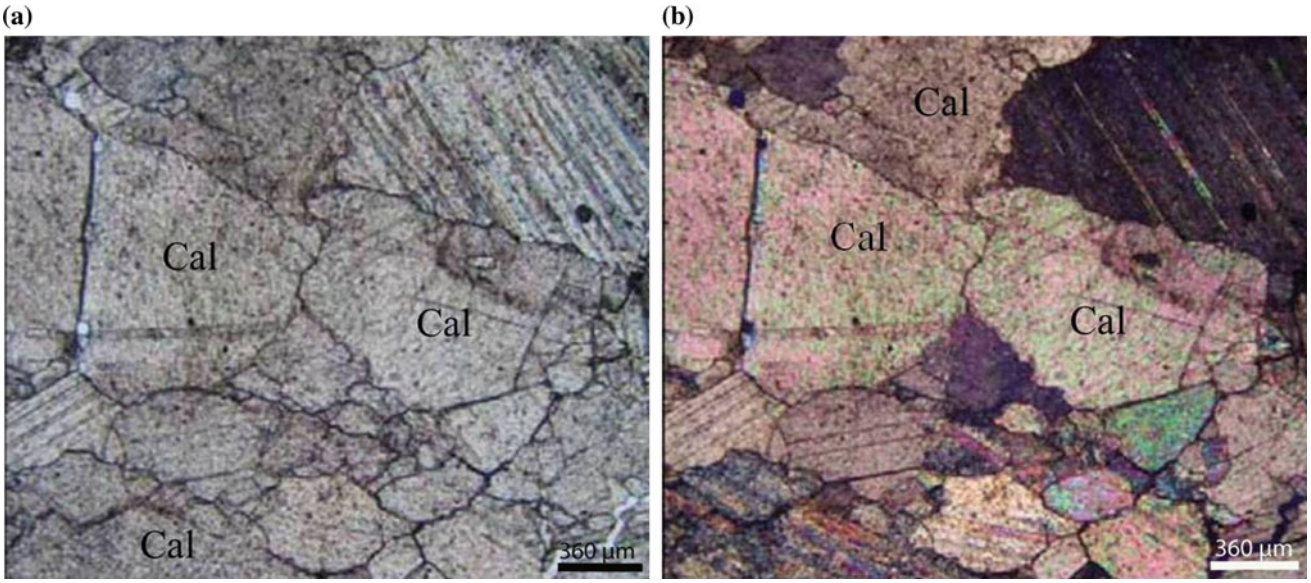

Fig. 2.9 Light microscope images of the thin section of white, mostly coarse-grained marble of the monument to the Unknown (N-18 No. 592) (Hereinafter, the numbers of the Unknown monuments are given according to the "Database on the state of sculptural monuments of St. Petersburg". The cipher N-18 indicates to the location of the monument in the Necropolis of the 18th century.): **a** PPL, **b** XPL. There is banding due to polysynthetic twinning

amphiboles (tremolite, hornblende), pyroxenes (diopside), talc, chlorites, mica (phlogopite) and feldspars (microcline) present in the rock. The content of silicate minerals may be comparable with the content of carbonate ones. The carbonate grain size (of isometric and irregular forms) vary substantially (from 0.1 to 6 mm). Dark gray, sometimes wavy, bands are due to the presence of dark-colored minerals and finely-dispersed carbonaceous substance. Green amphibole crystals sometimes form radiate aggregates.

In the thin section of the marble from E.A. Rummel's memorial (Fig. 2.12a), it is easy to see different-sized, generally isometric, carbonate grains. The groundmass of the rock is composed of 0.6–4 mm grains. In some areas their size is 0.1–0.3 mm. Between large grains of carbonates, chain aggregates of smaller ones are often observed. Amphibole (tremolite) is present in the form of columnar crystals and their aggregates and is confined, for the most part, to the fine-grained component of the rock. In

Fig. 2.10 Monument to S.K. Münnich from gray banded marble (Necropolis of the 18th century)

intergrowth with amphibole, small lamellar crystals of weakly pleochroic mica are found. A few small grains of quartz can be seen.

Mineralogical and petrographic characteristics of the silicate-carbonate rock under investigation are typical for the Ruskeala marble field (Fig. 2.12b) (Kitsul 1963; Bulakh 2005). This deposit, which is located in the area north of Lake Ladoga near the village of Ruskola (Ruskeala) near the town of Sortavala (Karelia), has been under development since the middle of the 18th century. At present, on the basis of the Ruskeala open casts, where marble was quarried to face the walls of St. Isaac's Cathedral, the Natural Park of Ruskeala operates (Fig. 2.13), which annually hosts thousands of tourists from different countries (Borisov 2008a).

In the Necropolis of the 18th century there is also gray, gray-white wide-banded marble (Fig. 2.14). In appearance, this marble is very similar to that from Ruskeala and differs from it only in the greater width of the bands and their more intense colour. Marble was used in the manufacture of sarcophagi and individual decorative elements. Memorial monuments of D. Frederiks, P.A. Polyansky, A.A. Polyanskaya, V.D. Smirnov are made of this marble.

The results of field and laboratory studies of the wide-banded marble of the tombstone of D. Frederiks (Fig. 2.15a) confirmed the similarity of this rock to the Ruskeala marble. The size of the carbonate grains (mainly calcite, and dolomite—to a much lesser extent) varies from fractions of a millimetre to 7 mm. Mica (mainly phlogopite) forms monomineral aggregates. There are areas of weak brecciation, where among the abraded mineral mass grains of carbonates are found (up to 1.5 mm). The colour of dark bands is due to the presence of dark-coloured minerals and finely dispersed carbonaceous matter.

The examined silicate-carbonate rock, both in appearance and in its mineralogical and petrographic characteristics is close to the marble that was mined in the northern Ladoga area on the island of Uven (Fig. 2.15b).

This coastal island (Fig. 2.16) (150 m long and 80 m wide) is located off the village of Läskelä, close enough to the village of Ruskeala. The Uven marble belongs to the complex of carbonate and silicate-carbonate rocks of the Ruskeala deposit. The Uven pits were in operation from 1769 till the early 19th century, and abandoned because of tough mining conditions (Borisov 2008a). This marble was used in the external and internal decoration of the Marble Palace (Ukhnalev 2002) and other architectural structures of St. Petersburg (Bulakh and Abakumova 1987, 1993; Bulakh 2005, 2012).

One of the most beautiful marbles of the Necropoleis is the pink veined inequigranular marble (Fig. 2.17). It is diverse in colour patterns (from pink, gray-pink, white-pink to crimson and violet). The colour of the rock is unevenly distributed and is determined to a large extent by the quantitative ratios of oxides and hydroxides of iron. Marble can be uniform, banded, brecciated, which is often emphasized by different shades of colour (Fig. 2.18). It contains veins of calcite and quartz. Of this marble, pedestals and semicolumns were usually made: the gravestones of L.I. Kusheleva, V.N. Bibikova, S.A. Balakshin, A.D. Litke, and A.V. Khrapovitsky.

The results of field observations and laboratory studies of pink marble have shown that the rock is composed of isometric grains of carbonates (calcite and dolomite in different ratios). The size of the grains varies from 0.05 to 1.2 mm. There are also large (up to 5 mm) dolomite grains of diamond shape. Quartz is present in the form of isolated grains and their small aggregates (Fig. 2.19a).

According to its appearance and mineralogical and petrographic features, the examined carbonate rock is similar to

Fig. 2.11 Monument to E.A. Rummel from gray heterogeneous marble: **a** general view, **b** fragment of the rock. Gray-green stripes and spots can be seen

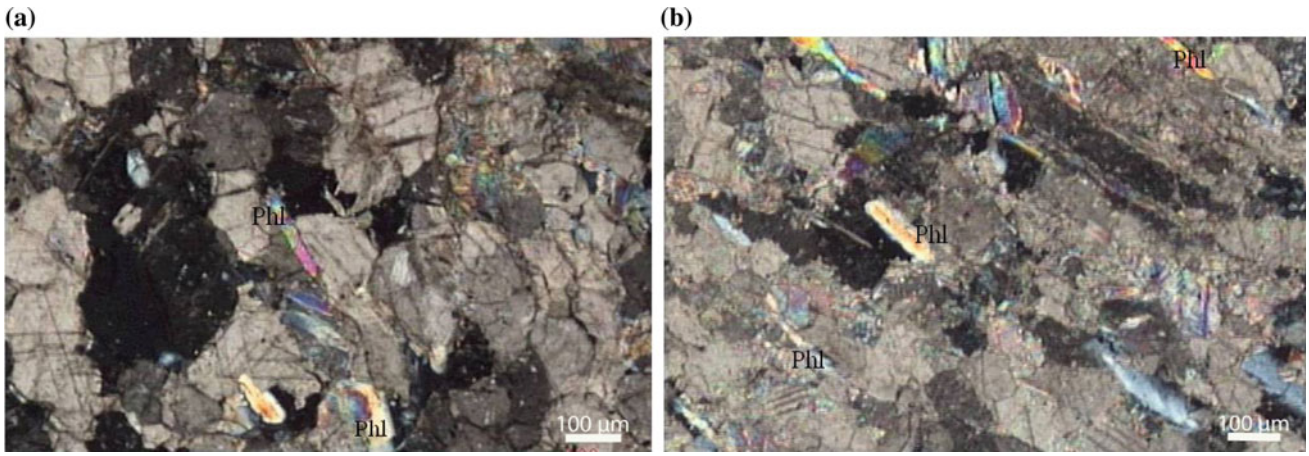

Fig. 2.12 Light microscope images (XPL) of the thin sections of gray heterogeneous banded marble: **a** the monument to E.A. Rummel, **b** Ruskeala deposit (Karelia) . In the mass of carbonate grains, lamellar crystals of mica (phlogopite—Phl) can be seen

the Belogorsky (Tivdiysky, Olonetsky) marble (Fig. 2.19b). This marble was quarried in Lake Onega area from the 18th century. It is usually called the Tivdiysky (after the name of the village—Tivdiya), or Belogorsky (by the place of the main open casts near the village of Belaya Gora), or Olonetsky (according to the ancient name of the land). The Belogorsky open cast is one of the largest mining and geological sites of Karelia, interesting for the variety and artistic value of its marbles (Fig. 2.20).

The Tivdiysky marble adorns the facade of the Marble Palace (pilasters, columns, insets above the windows, the frieze, attic, tower) and interiors of many other palaces and cathedrals in St. Petersburg (Bulakh and Abakumova 1987, 1993).

In the Necropolis of the 18th century there are also very unusual, picturesque breccia and breccia-like marbles.

Variegated breccia marble (Fig. 2.21). The rock consists of cemented blocks of various sizes (from 0.8 mm to 5 cm)

Fig. 2.13 Marble quarries of Ruskeala (Karelia). Photos by Dmitry Yu. Vlasov, 2008

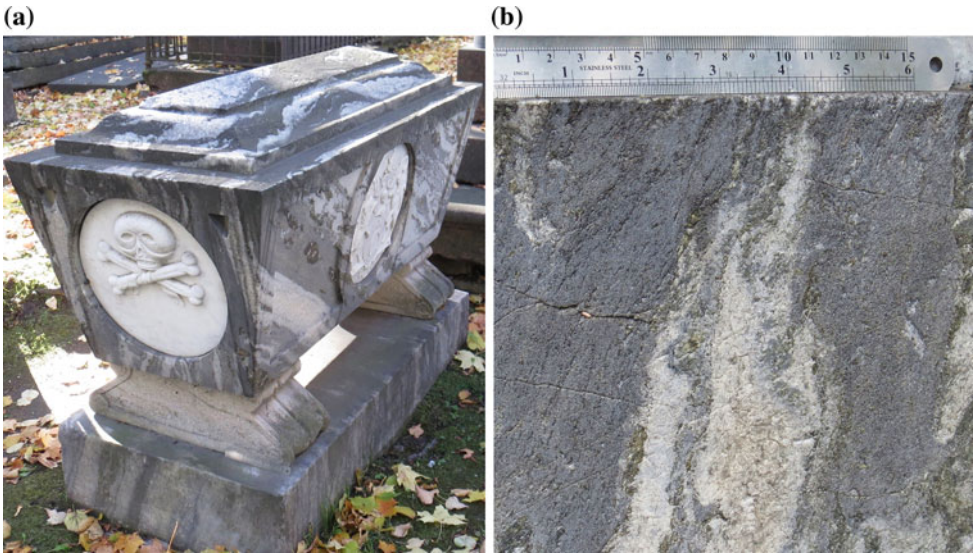

Fig. 2.14 Monument to A.A. Polyanskaya from gray-white wide-banded marble: **a** general view, **b** fragment of the rock. The width of the bands reaches 10 cm

and colours (from light yellow and white to pink and even violet). This marble can be seen in the Necropolis of the 18th century only on three tombs, of Georgian princess Maria Alexandrovna (née Khilkova), A.P. Berilova, E.I. Kokoshkina.

The study of the marble of A.P. Berilova's tomb showed that the rock is a fine-crystalline aggregate of mostly calcite and dolomite (with grain size of 0.05–0.1 mm) (Fig. 2.22). It contains segregations of up to 9 mm, made of large (up to 1.5 mm) carbonate crystals. In the marble of the monument

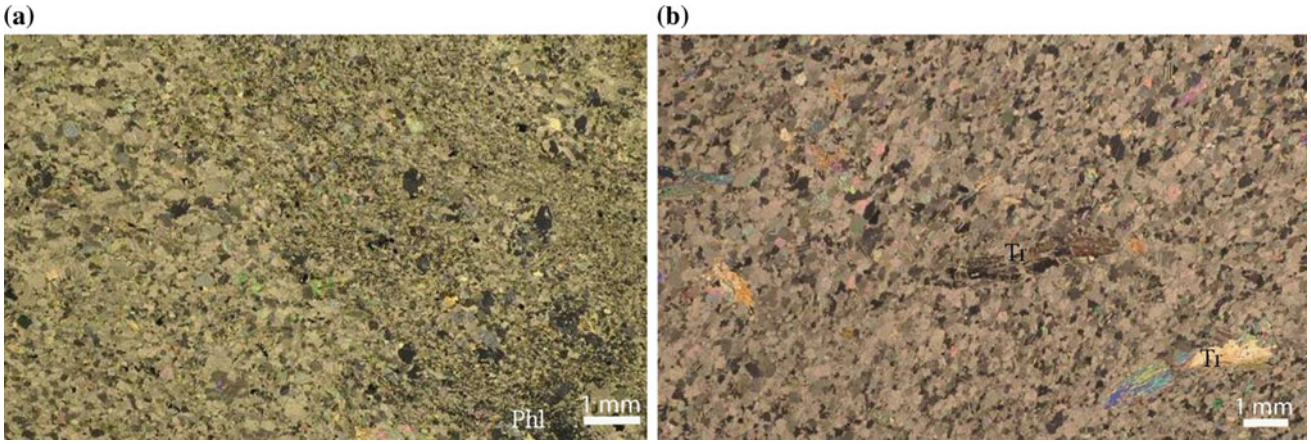

Fig. 2.15 Light microscope images (XPL) of the thin sections of gray-white wide-banded marble: **a** the monument to D. Frederiks, **b** the Uven field (Island of Uven). In the fine-grained carbonate mass, grains of silicate minerals are visible: mica (phlogopite—Phl) and amphibole (tremolite—Tr)

Fig. 2.16 Island of Uven (Karelia) . Photos by Dmitry Yu. Vlasov, 2008

to Maria Alexandrovna in addition to calcite, calcium silicate larnite was found.

According to the archive of the State Museum of Urban Sculpture the marble for Maria Alexandrovna's memorial was imported from Italy (Artistic Tombstone 2006). It is known that deposits of colourful varieties of marble with angular clasts are found in Italy near the cities of Verona and Carrara (Shuman 1986). Vases of amazing beauty made from Italian breccia marbles of different colours can be seen in the State Hermitage.

Gray-white spotted brecciated marble (Figs. 2.23, 2.24). The rock is very heterogeneous. The breccia-like look is due to unevenly distributed patchy colouration and numerous multidirectional veins of calcite of varying length and

Fig. 2.17 Monument to V.N. Bibikova from pink patterned marble (Necropolis of the 18th century)

thickness. Calcite veins have greater resistance to the impact of the environment, and therefore a web of bulging segregations is formed on the rock surface.

Gray-white spotted brecciated marble is more common in the Necropolis of the 18th century than the motley one. It was used in the manufacture of various parts of gravestones —pedestals, semicolumns, etc. (monuments to N.A. Mordvinov, E.A. Kurakina, A.P. Berilova, E.I. Kozitskaya).

The laboratory studies of the rock showed that it is dominated by fine-grained calcite aggregate and dolomite. Quartz, diopside, larnite, and mica are present as impurities. In the marble of N.A. Mordvinov's gravestone there is a small area of calcite grains of 0.05–0.20 mm in size. In the marble of the monument to A.P. Berilova (Fig. 2.25), a section is composed of isometric carbonate grains 0.1–1.0 mm in size, with a predominant size of 0.3–0.6 mm. Among these grains, numerous lamellar crystals of mica of roughly the same size and individual grains of pyroxene are evenly distributed. The fine- and medium-grained area is replaced by a coarse-grained section of large (up to 2.5 mm) calcite grains with serrated edges. On the whole, it can be seen that the carbonate rock under investigation is a limestone where, as a result of repeated non-uniform recrystallization, marmorized sections were formed.

It is known that the white marble for the sarcophagus of the monument to N.A. Mordvinov was mined in Carrara after the model of the "famous sarcophagus in Rome" (Artistic tombstone 2006), which suggests that the gray-white brecciated marble (marmorized limestone) for this and other monuments was imported from Italy. According to the Italian geologist Lorenzo Lazzarini, the rock looks like Portoro limestone, quarried in the province of La Spezia.

White with a yellowish tinge, slightly brecciated marble. This marble was used for the monument to N.A. Rimsky-Korsakov (Fig. 2.26) in the Necropolis of the Masters of the Arts. The monument was carved according to the sketch by N.K. Roerich and has a high artistic value. It is known that the authors sought to age the stone artificially and for this purpose they gave it a light yellow shade (http://lomonosov.org).

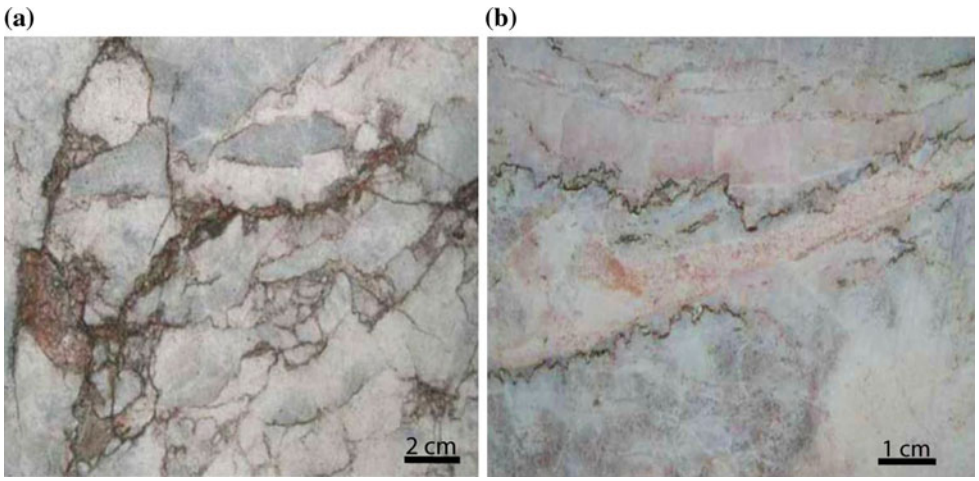

Fig. 2.18 Pink patterned marble: **a** brecciated (the monument to L. I. Kusheleva), **b** banded (the monument to V.N. Bibikova) (Esipova 2006)

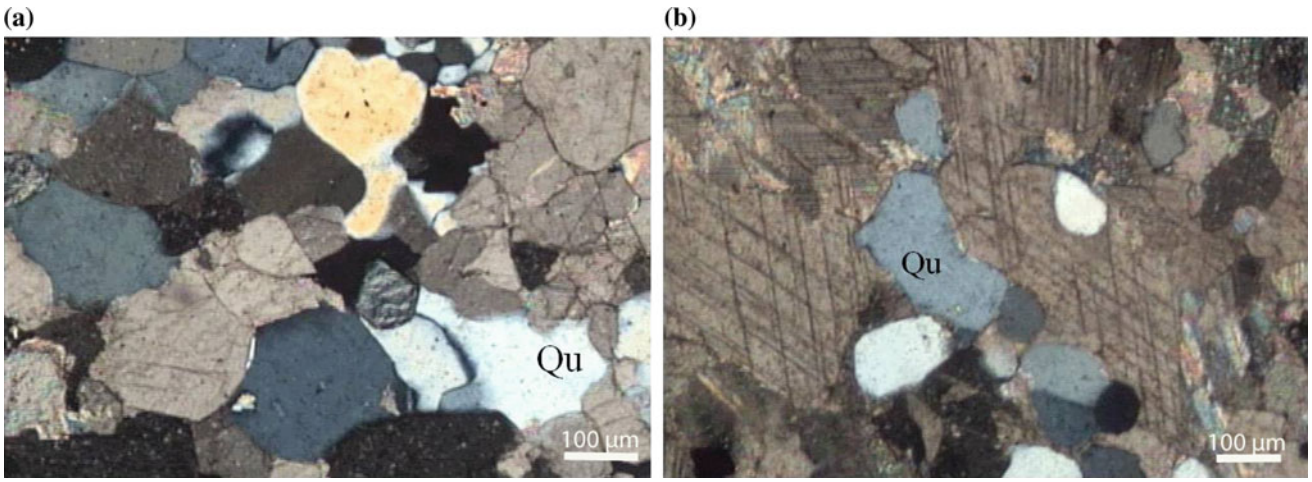

Fig. 2.19 Light microscope images (XPL) of the thin sections of pink patterned marble: **a** the monument to the Unknown (N-18 No. 699), **b** the Belogorsky deposit. Among the carbonate grains, quartz grains (Qu) can be seen (Esipova 2006)

Fig. 2.20 Tivdiysky stone quarry (http://regionavtica.ru)

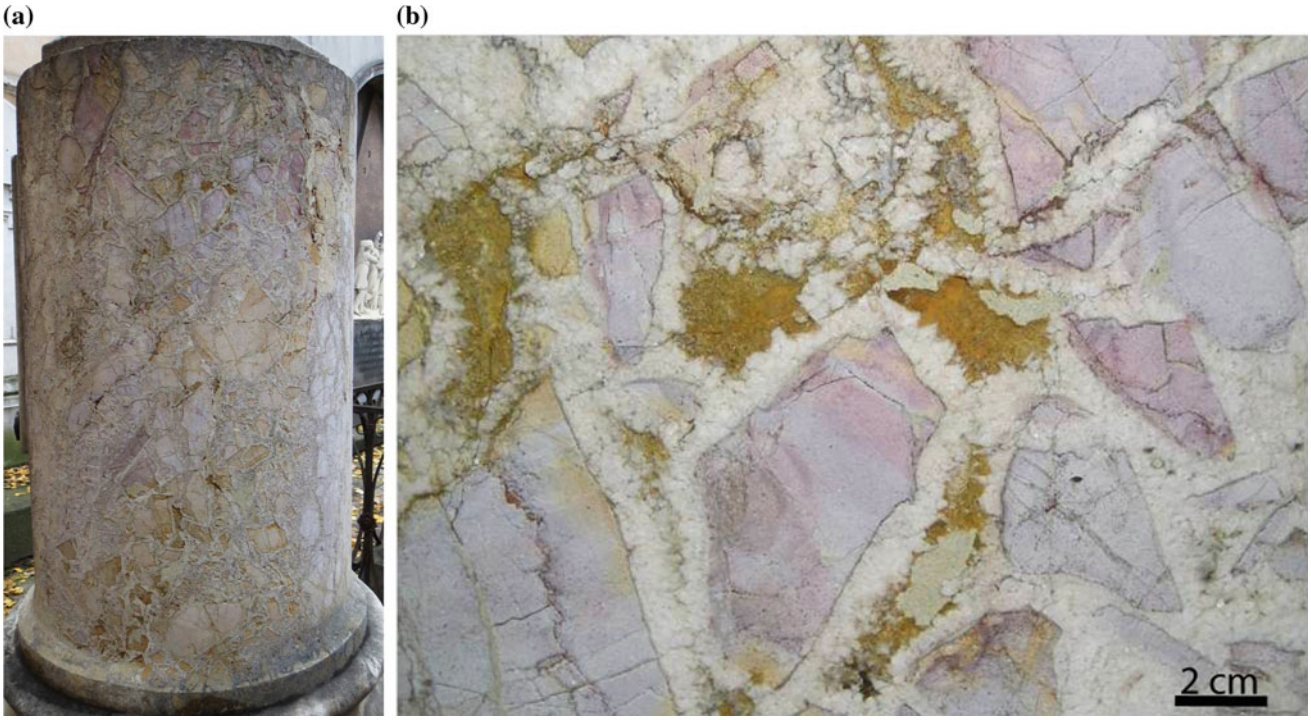

Fig. 2.21 Pillar of the monument to the Georgian princess Maria Alexandrovna (née Khilkova) from the mottled breccia marble (Necropolis of the 18th century): **a** general view, **b** fragment of the rock

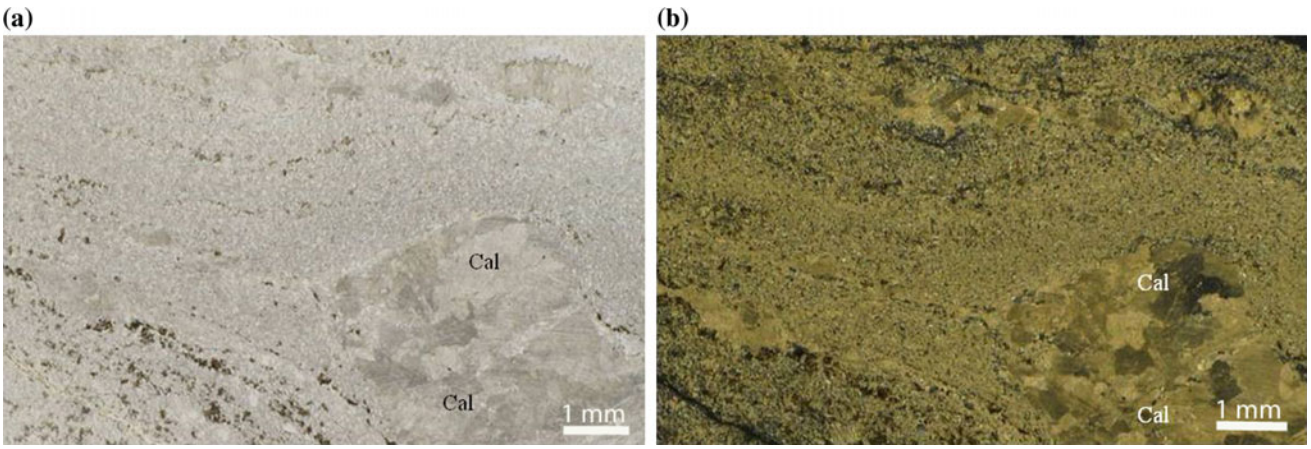

Fig. 2.22 Light microscope images of the thin section of mottled brecciated marble of the monument of A.P. Berilova: **a** PPL, **b** XPL. In the fine-grained carbonate mass clusters of coarse calcite grains can be seen

The laboratory study of the marble showed that in a small- and medium-grained calcite aggregate there are areas of coarse-grained aggregation and those of columnar crystals (Fig. 2.27). In addition, lamellar crystals of biotite are present, almost completely replaced by fine flaky aggregates of light mica. Grains of quartz are observed mainly in the fine-grained part of the rock. Where the marble for N.A. Rimsky-Korsakov's tomb was brought from remains unknown.

2.2 Limestone

Carbonate rocks of the Necropolis are represented not only by marbles, but also by various limestones.

The most common of these is *multicolored flaglike limestone* (Fig. 2.28). Its clearly manifested stratification is emphasized by the presence of thin clay partings and different colour layers, whose thickness is usually 5–20 cm. Gray,

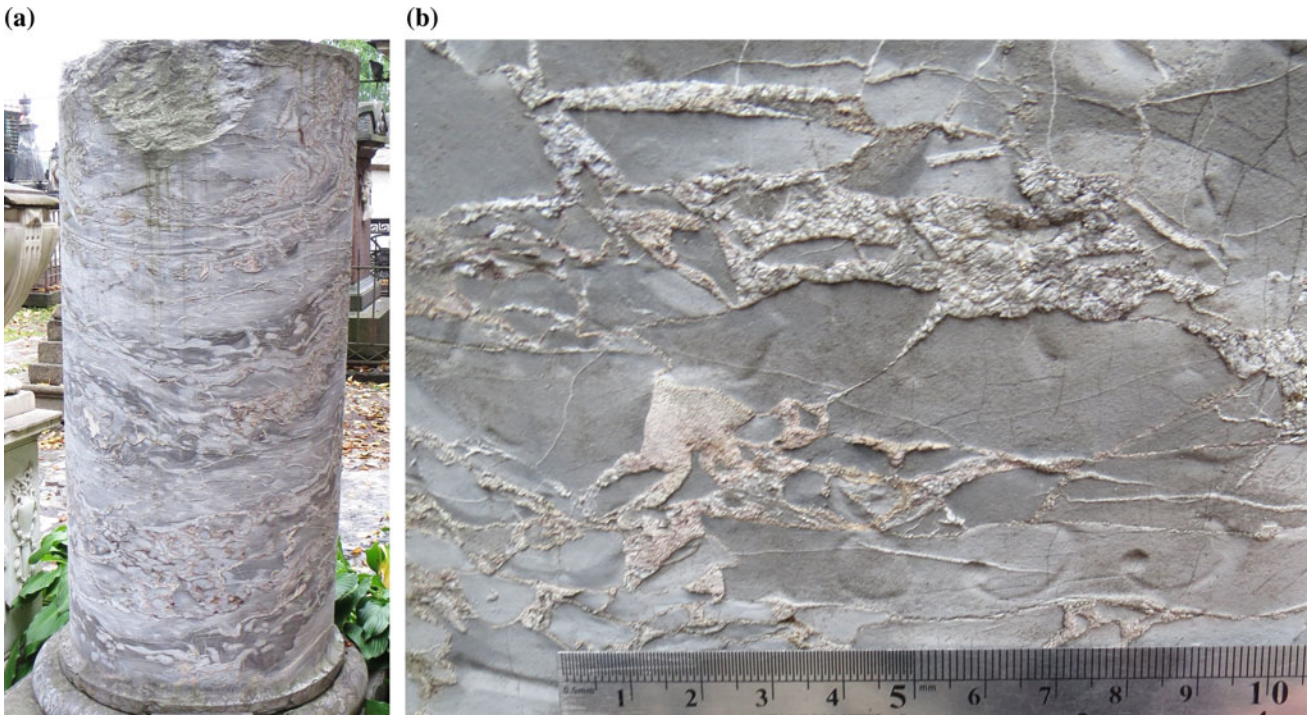

Fig. 2.23 Monument to E.I. Kozitskaya from gray-white brecciated marble: **a** – broken column, **b** fragment of the rock

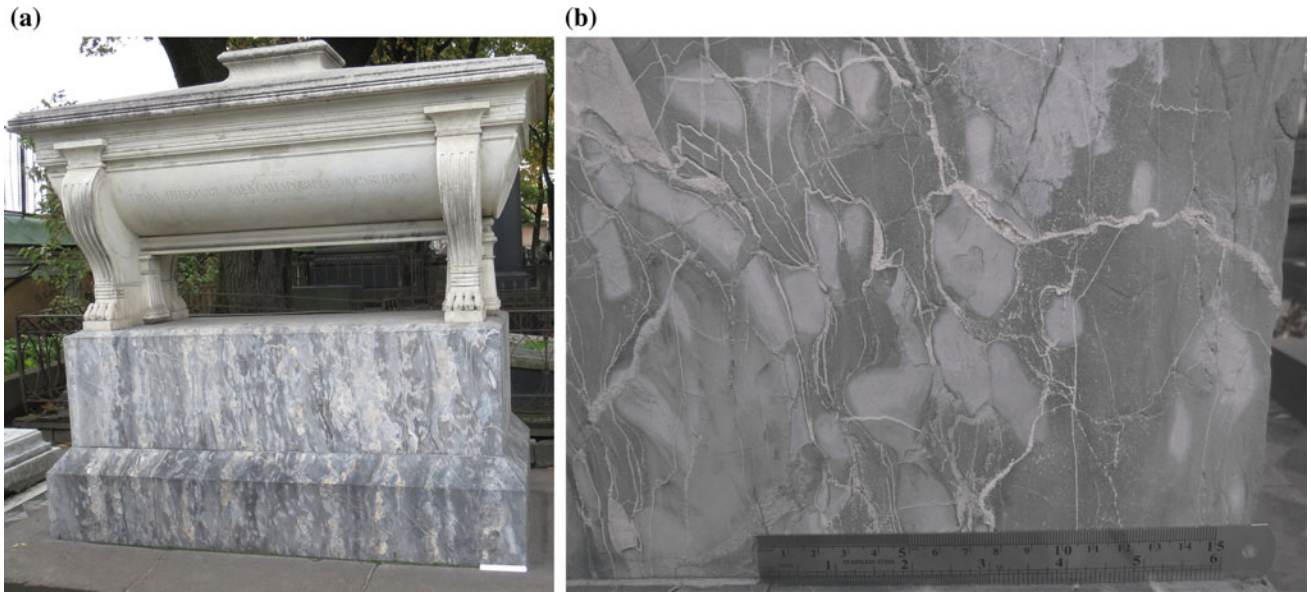

Fig. 2.24 Monument to N.A. Mordvinov from gray-white brecciated marble: **a** general view, **b** fragment of the rock. Color spots are visible

yellowish-gray dense limestone, often with brown spots is the most common in the Necropolis (Fig. 2.29). There are also grayish-green, gray-pink, rusty-yellow (ochre-coloured), brownish-red, pink-violet varieties. Numerous fossils can be seen. Foundations of most of the memorials in the Necropolis are made of such limestone. For the manufacture of semi-columns, sarcophagi, tomb canopies it was used more seldom (monuments of A.Y. Potemkina, F.I. Ivanov, Y.B. Knyazhnin, S.I. Lavrov, I.I. Cherkasov, I.I. Arbenev).

The laboratory studies have shown that the flaglike stratified limestone of the Necropolis monuments is predominantly a fine-grained dolomitized carbonate rock (Fig. 2.30a, b). The main rock-forming mineral is calcite. Areas of recrystallization with coarser grains are observed.

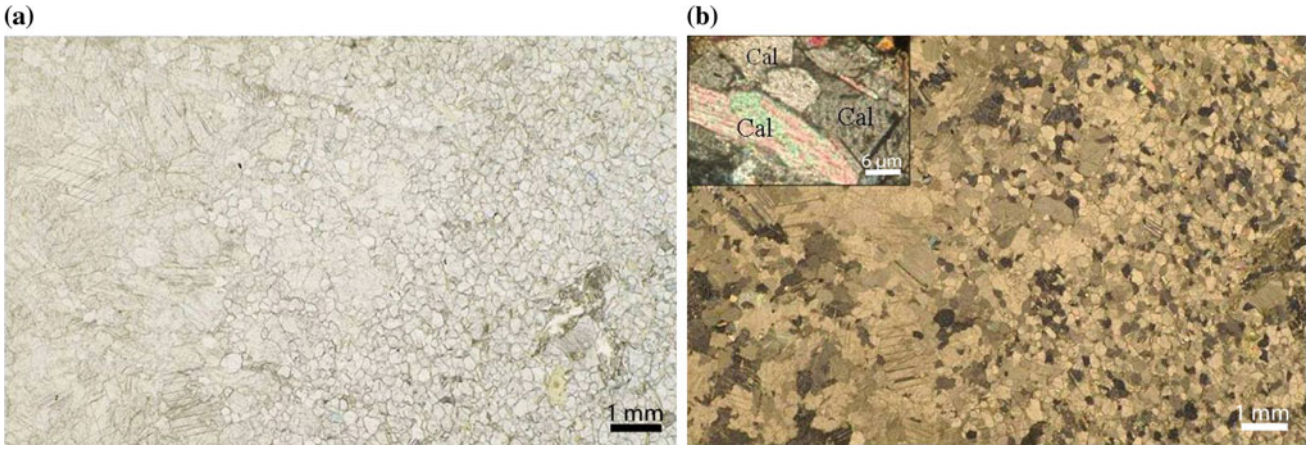

Fig. 2.25 Light microscope images of the thin section of gray-white spotted brecciated marble of the monument to A.P. Berilova: **a** PPL, **b** XPL

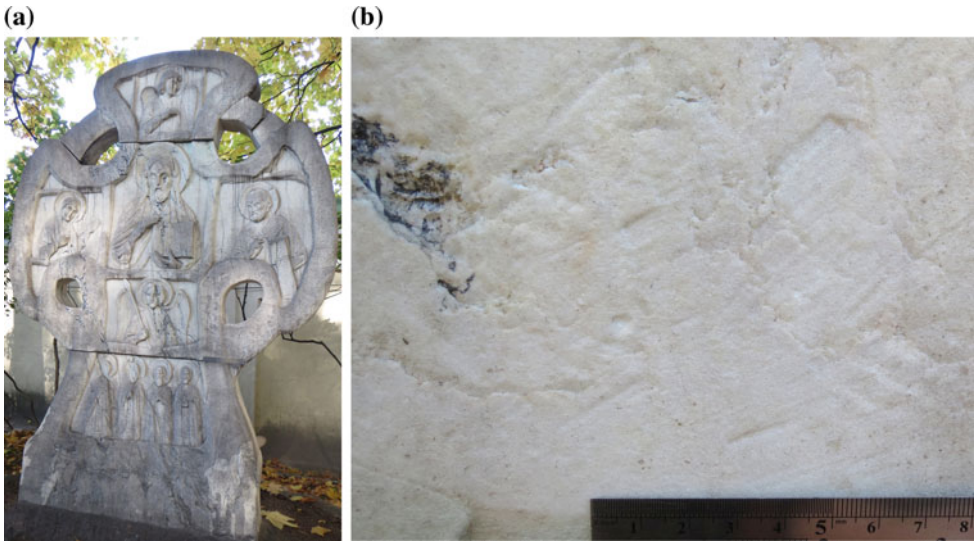

Fig. 2.26 Monument to N.A. Rimsky-Korsakov from white-and-yellowish marble: **a** general view, **b** fragment of the rock with traces of secondary changes

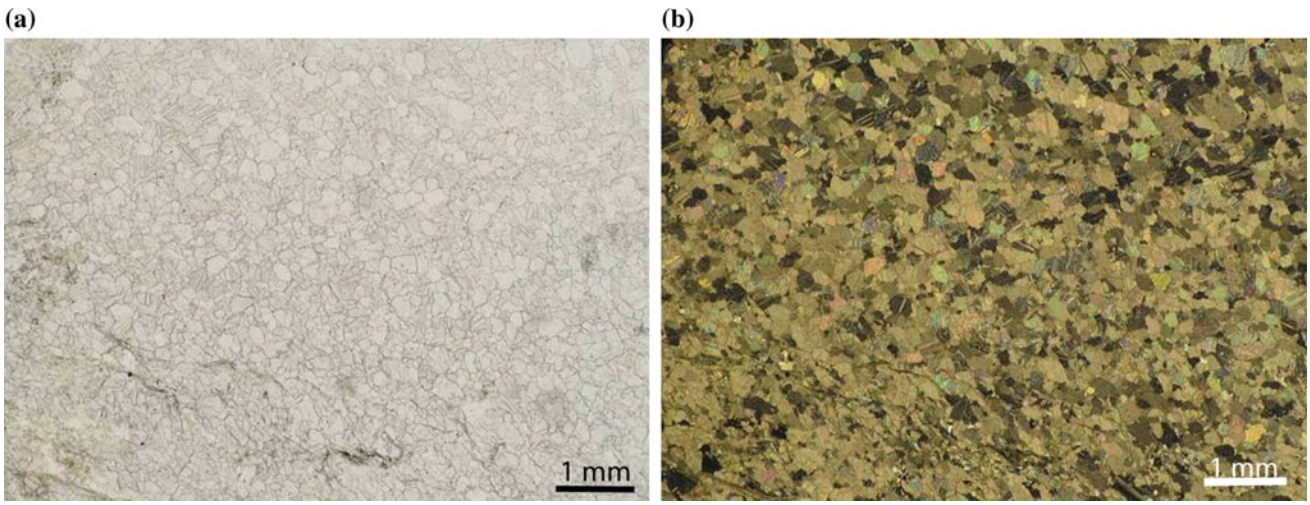

Fig. 2.27 Light microscope images of the thin section of white, slightly brecciated, yellowish-tinged calcite marble of the monument to N.A. Rimsky-Korsakov (thin section): **a** PPL, **b** XPL

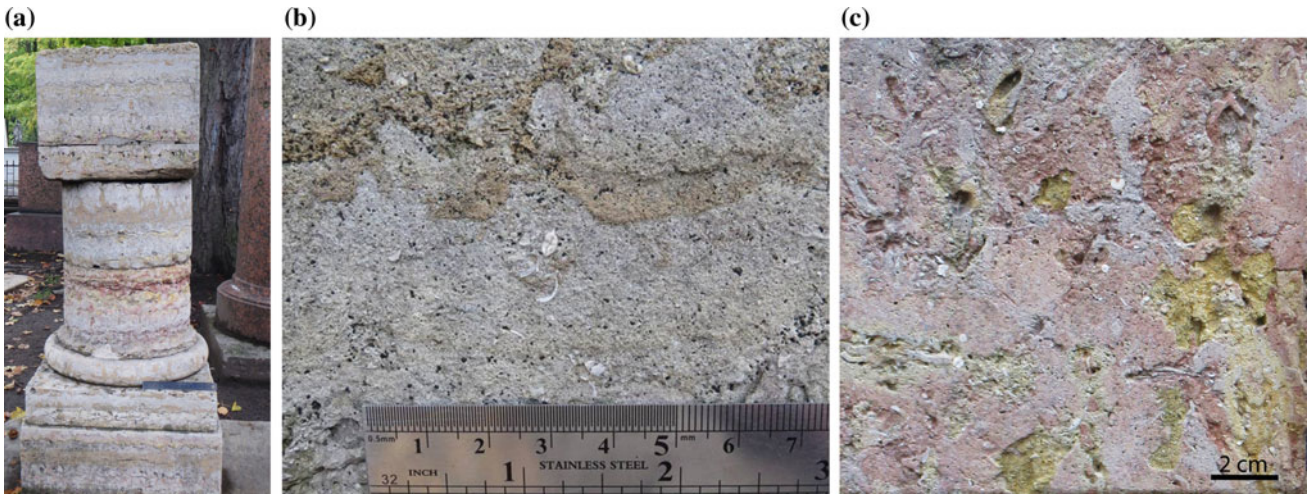

Fig. 2.28 Monument to Ya.B. Knyazhnin from the variegated flaglike limestone: **a** general view of the monument from the east; **b** gray part of the rock, traces of ferruginization; **c** pink-violet part of the rock, green speckles are visible

Fig. 2.29 Gray flaglike limestone with yellow-brown interlayers

There are large diamond-shaped crystals of dolomite. The limestone contains a great amount of faunal organic remains. This determines the bioclastic structure of the rock. A characteristic feature of flaglike limestone is the presence of green mineral grains—those of glauconite (iron potassium phyllosilicate). In addition, there is quartz.

The structure of the rock, its mineral composition and abundance of organic remains are characteristic of the limestones from the Putilovo deposit (Fig. 2.30c, d). The deposit of Putilovo stone is located in the Leningrad region (near the village of Putilovo) (Fig. 2.31). Flaglike limestone was mined there from the early 18th century and was one of the main materials used in the construction of St. Petersburg. The main areas where it was quarried were the southern coast of Ladoga Lake, lower reaches of the Volkhov River, the basins of the Syas River, and of the Tosna and Sablinka rivers. Currently, there are only two quarries located in the areas where Putilovo limestones were originally excavated —Babino Seltso and Putilovsky (Harjuzov et al. 2012).

In the Necropolis of the 18th century there is also *gray dense limestone* (Fig. 2.32). The colour of the rock varies from light gray to grayish black. The rock is full of small fossilized fauna. Such limestone was usually used for pedestals, stands for vases and various decorative elements. From it, details of the monuments to S.N. Marin, Ketavana Konstantinovna (née Bagration-Mukhrani), A.G. Kusheleva, A.S. Belavina, and others were made.

The results of the study of the gray limestone of A.G. Kusheleva's tomb showed that this was a fine-grained crystalline carbonate rock composed of calcite, to a much lesser extent of dolomite, with an admixture of clayey material (Fig. 2.33). Numerous faunal remains can be seen. Quartz and clayey minerals are found as impurities.

It is known that gray, dense, fossil-containing marmorized limestone is mined in Germany (Bavaria). This is so-called Jurassic marble, which was mined as early as in the Middle Ages (Shuman 1986) . It is possible that it was this limestone that was used for the Necropolis monuments.

Porous, spongy, gray or yellowish-gray limestone—travertine is much rarer in the Necropolis of the 18th century (Fig. 2.34). There are portions of brown or yellowish-brown colour, stained by oxides and hydroxides of iron (Fig. 2.35). Such limestone, which is often called calcareous tufa, was used in the manufacture of canopies, grottoes, pyramids (memorials of N.S. Bem, P.A. Golitsyna, V.I. Potemkina, and others).

The results of laboratory studies of the travertine of the monument to the Unknown (N-18 No. 901) in the Necropolis of the 18th century showed that the examined limestone is a highly porous rock composed of fine crystalline or

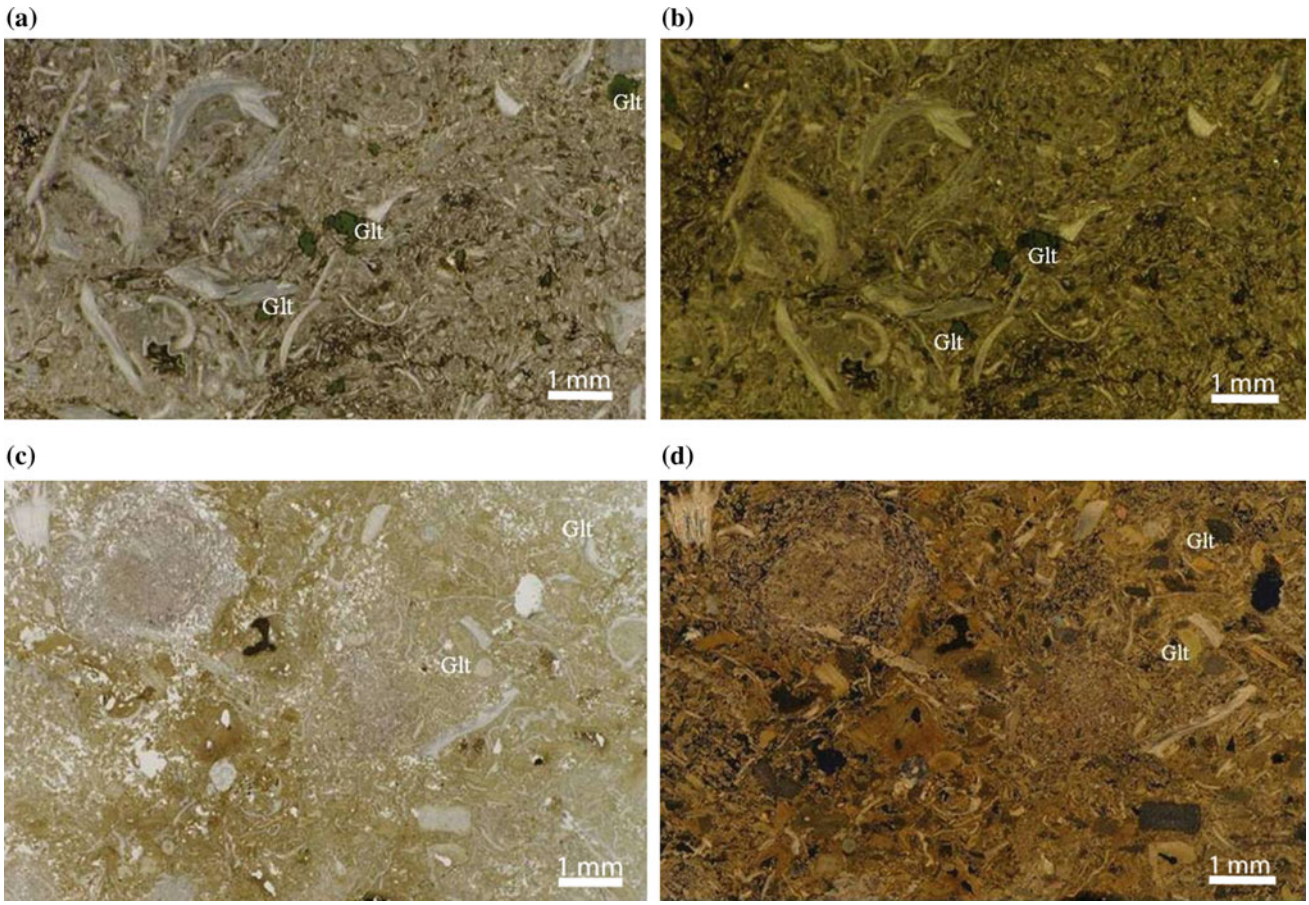

Fig. 2.30 Light microscope images of the thin sections of the flaglike limestone of the monument to the Unknown (N-18 No. 160) in the Necropolis of the 18th century (**a**, **b**) and from the Putilovsky deposit (**c**, **d**): **a**, **c** PPL, **b**, **d** XPL. There are numerous fragments of shells and green grains of glauconite (Glt)

Fig. 2.31 Putilovsky deposit. Photo by Aleksandr M. Marugin, 2007

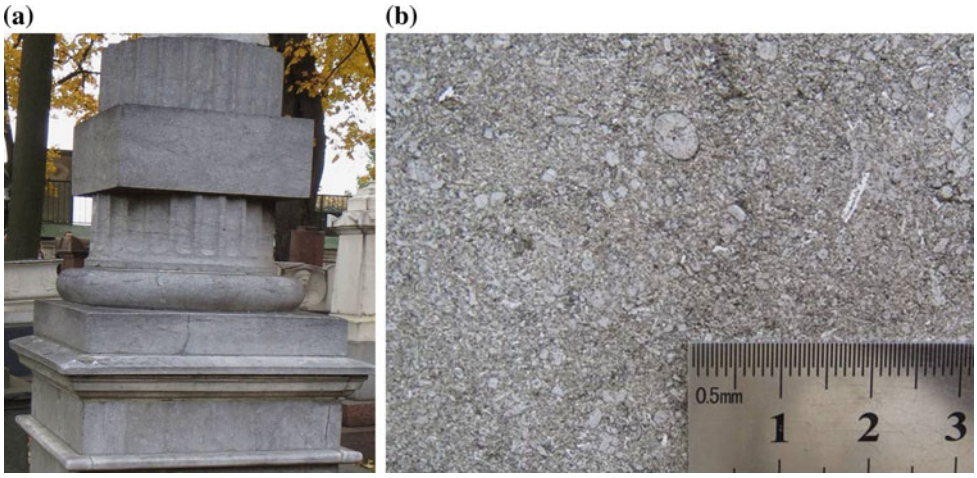

Fig. 2.32 The pedestal of the monument to S.N. Marin from gray dense limestone: **a** general view, **b** fragment of the rock

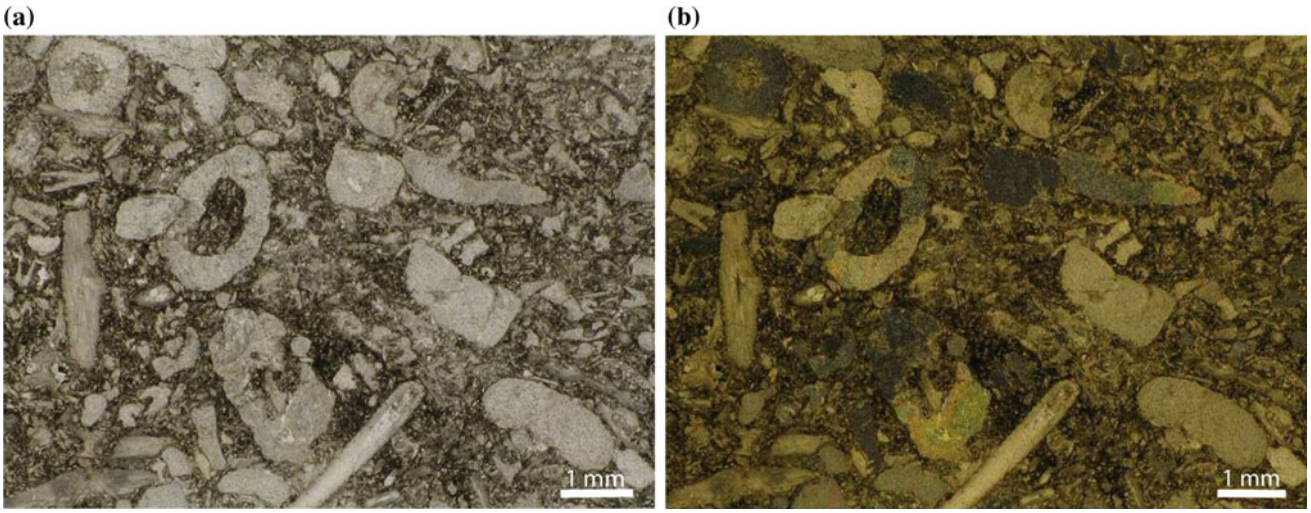

Fig. 2.33 Light microscope images of the thin section of gray limestone of the monument to A.G. Kusheleva: **a** PPL, **b** XPL. Numerous fragments of fossilized fauna are visible

cryptocrystalline carbonate (mainly calcite, rarely dolomite) (Fig. 2.36). Quartz is found as an impurity.

Textural and structural features of the travertine are characteristic for the biochemical limestones of the Pudost deposit (Fig. 2.36) located in the Leningrad region in the valley of the Izhora River, near the village of Bolshaya Pudost (Fig. 2.37). The first deliveries of calcareous tufa to St. Petersburg began in 1706–1713 when fountains and grottos were built in the Summer Garden in the Western fashion (Bulakh 2012). One of the last references to the use of Pudost stone dates back to 1965–1969, when it was quarried for the restoration work on the Kazan Cathedral (Gavrilenko 2007; Bulakh 2012).

For the tombs of F.P. and A.I. Tolstoys in the Necropolis of the 18th century, *gray-white spotted brecciated limestone* was used (Fig. 2.38).

The limestone is rich in fossilized fauna. The blotchy colour of the rock makes it look brecciated.

By its gray-white colour scheme, patchy, sometimes banded, colour distribution the rock is close to gray-white marmorized limestone (brecciated marble) described in Sect. 2.1. Its main difference is the abundance of fossilized fauna. It can be assumed that the compared rocks belong to a single geological structure, and brecciated organic limestone was also imported from Italy.

2.3 Granite and Other Hard Rocks

Many monuments of the Necropoleis are made of granites and other hard rocks. The most common is pink, red-pink, brownish-pink porphyritic, often ovoid, granite (Fig. 2.39).

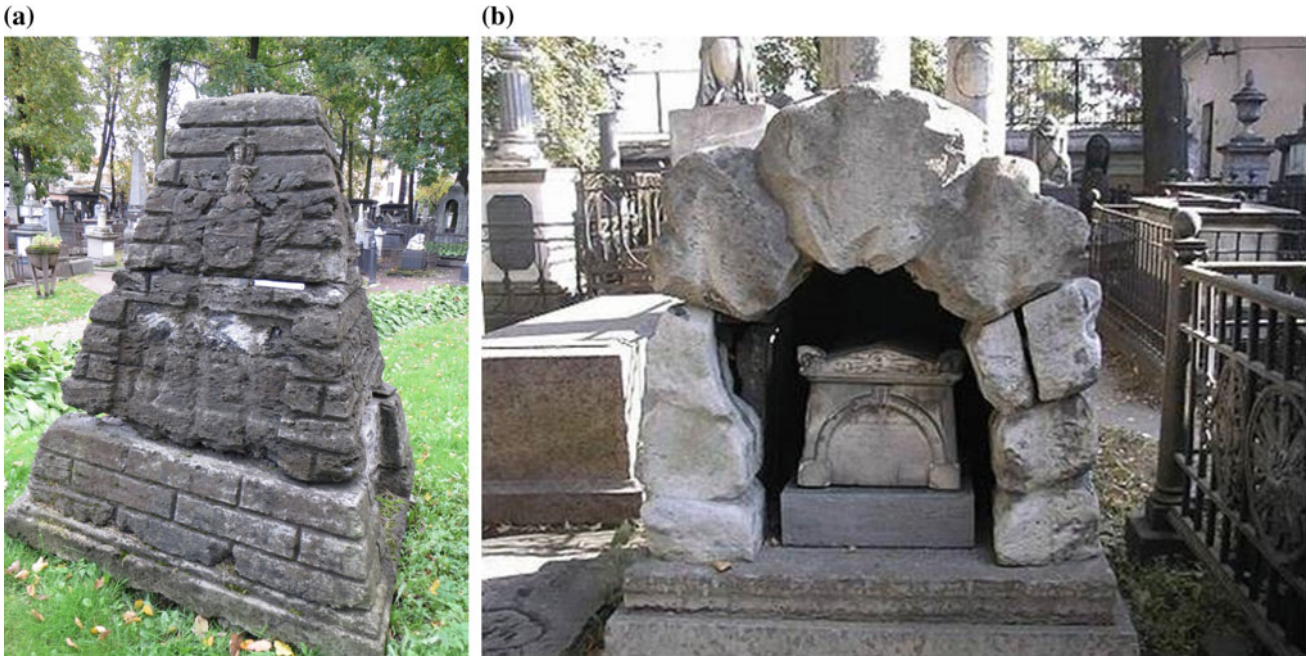

Fig. 2.34 Monuments from travertine: **a** to the Unknown (N-18 No. 901), **b** to P.A. Golitsyna

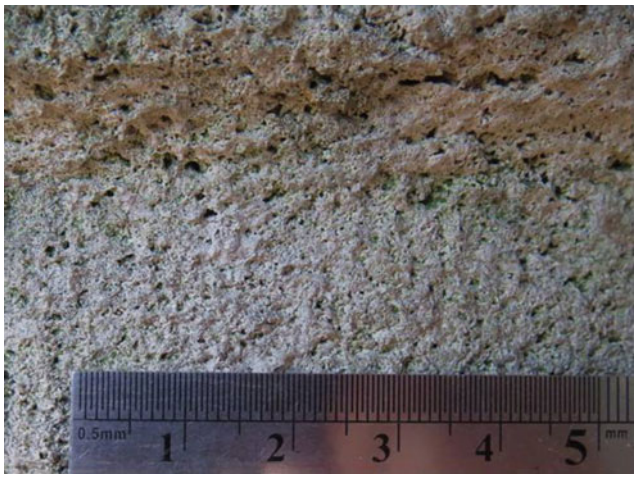

Fig. 2.35 Gray porous travertine with traces of ferruginization

Such material was mainly used for the foundations of monuments, pedestals, columns, semicolumns, steles. Memorials of V.V. Stasov, L. Euler, I.P. Martos, I.V., V.G., N.V. Kusovs and others were made from it.

On the surface of the granite of V.V. Stasov's tomb there are large (up to 8 cm) tabular crystals of potassium feldspar (microcline) immersed in the ground mass of the rock, composed of smaller quartz, feldspar and dark-coloured mineral crystals (Fig. 2.39b). In the thin sections it can be seen that microcline forms large (up to 13 mm) tabular crystals containing numerous intergrowths of plagioclase (Fig. 2.40a, b). Plagioclase (albite, oligoclase) is also present in the form of regular tabular crystals (0.3–0.5 mm), and quartz—in the form of separate isometric and angular grains and their clusters. Biotite and amphibole are found in the form of rare small intergrowths.

By its mineralogical and petrographic characteristics, the granite of V.V. Stasov's tomb (Fig. 2.40a, b) is similar to the porphyritic granite from the Montferrand quarry (Fig. 2.40 c), which is located in the South-East of Finland. From this granite the columns of St. Isaac's Cathedral and the Alexander Column in the Palace Square were carved.

Ovoid phenocrysts of pink feldspar (microcline, orthoclase) in porphyritic granite can reach 10 cm in diameter. Zonality is often manifested, formed by chains of inclusions of dark-coloured minerals (Fig. 2.41).

By their mineralogical and petrographic characteristics, pink, pink-red porphyritic ovoid granites of the Necropolis monuments are similar to rapakivi granites of the Vyborg massif. In St. Petersburg rapakivi granites and other pink porphyritic granites were supplied from the territories of the modern Leningrad region, Karelia and Finland (Ziskind 1989).

Brown-red equigranular granite (fine- and medium-grained or medium- and coarse-grained) is found in the Necropoleis much more rarely. In the Necropolis of the Masters of Art the pedestal of A.I. Kuindzhi's tomb (Fig. 2.42), and the gravestones of A.K. Glazunov, I.A. Melnikov, F.I. Stravinsky are made of this granite. It is known that this equigranular granite, called the Valaam

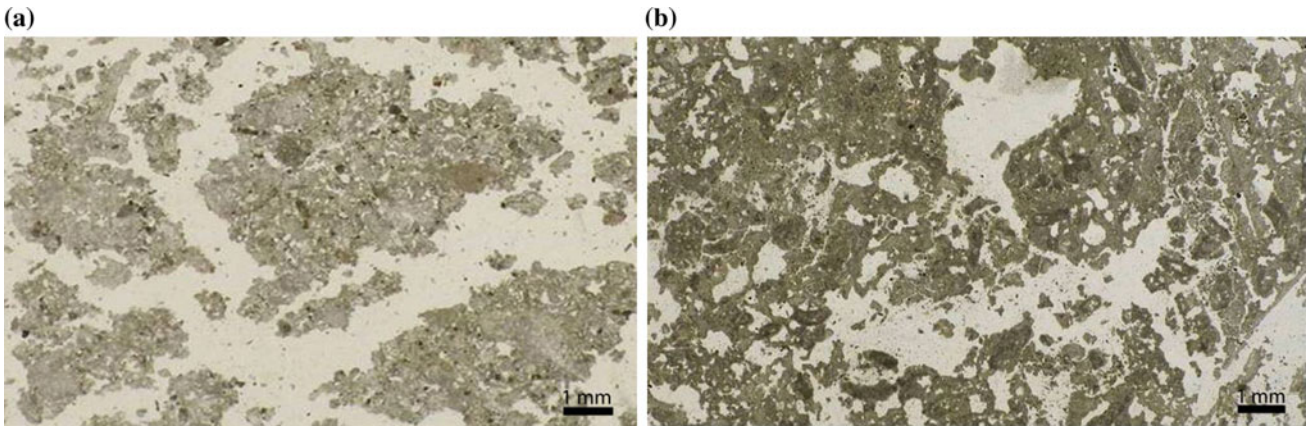

Fig. 2.36 Light microscope images (PPL) of the thin sections of highly porous travertines: **a** monument to the Unknown (N-18 No. 901), **b** pudost deposit

Fig. 2.37 Pudostsky quarry. Photo by Vera V. Manurtdinova, 2009

granite, is mined to date on Syskyjansaari Peninsula, located in the Ladoga Lake and connected to the mainland by a dam (Ziskind 1989). The similarity of rocks is manifest in their colour, structural features, qualitative and quantitative ratio of light-coloured and dark-coloured minerals (Fig. 2.43). The Valaam granite is often found in the decor of old and modern buildings in St. Petersburg.

The gravestone of G.A. Senyavin in the Necropolis of Masters of Art (Fig. 2.44) is close to Valaam granite in colour and mineral composition, but differs in its clearly manifested breccia texture and erratic distribution of rock-forming minerals and their aggregates. Where the rock was brought from is not established.

In the manufacture of the Necropolis monuments, gray, grayish-white, grayish-pink ovoid granite was also used. This is a medium-grained rock with large rounded feldspar inclusions (Fig. 2.45).

Gray rapakivi granites of the Vyborg Massif are known (Ziskind 1989); today quarries of this granite are near Vyborg and in Finland (south of Lappeenranta) (Bulakh 2012).

Gray ovoid granite was used in St. Petersburg from the end of the 19th century, for example, for the podium of the Stock Exchange and the pedestals of the Rostral columns. The obelisk “To Leningrad, the Hero-City” on Vosstaniya Square is made from it.

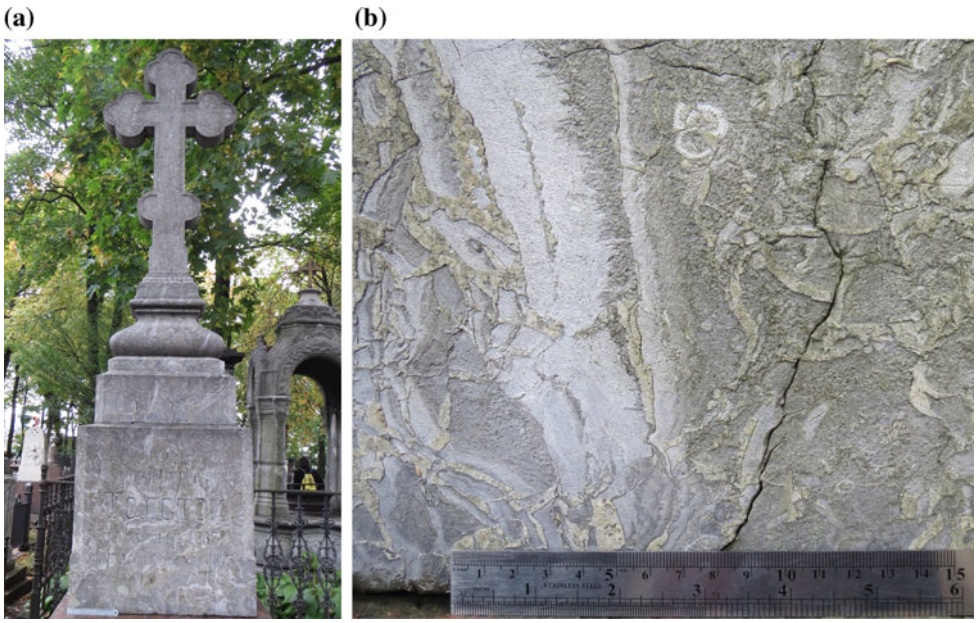

Fig. 2.38 Cross on the pedestal of the monument to F.P. Tolstoy from light gray spotted brecciated limestone: **a** general view, **b** fragment of the rock

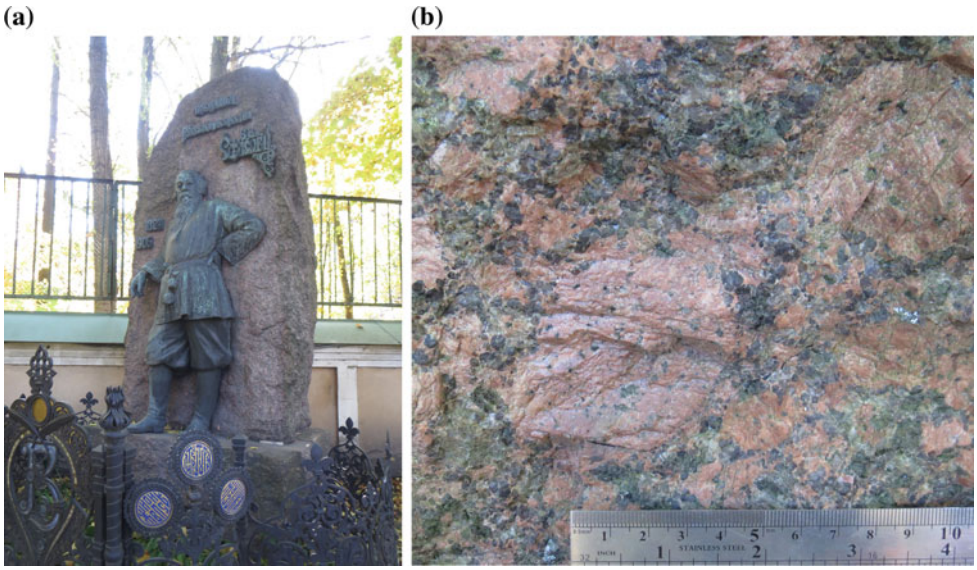

Fig. 2.39 Bronze portrait of V.V. Stasov against a block of pink coarse-grained granite: **a** general view of the monument, **b** fragment of the rock

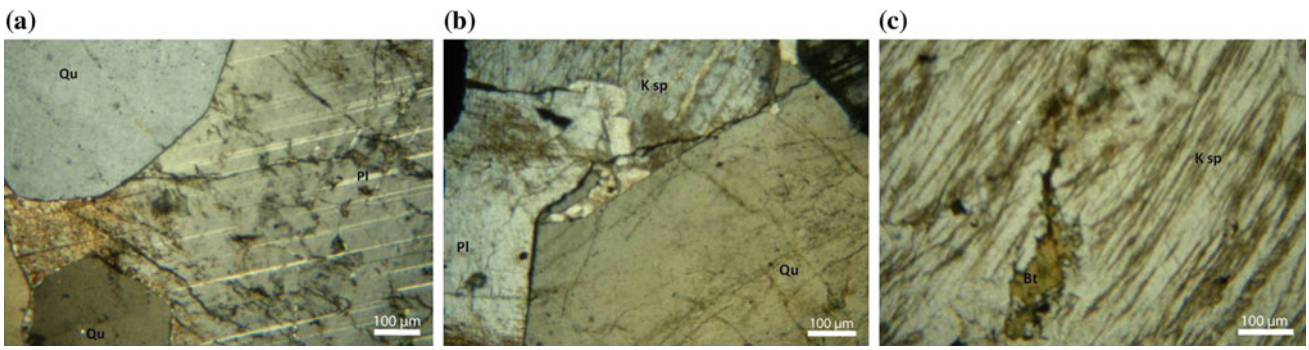

Fig. 2.40 Light microscope images (XPL) of the thin sections of pink porphyritic granite: **a**, **b** monument to V.V. Stasov, **c** Piterlaks (Piuterlahti) deposit, Montferrand's quarry. Legend: plagioclase—Pl, potassium feldspar (microcline—Mi), mica (biotite—Bt), quartz—Qu

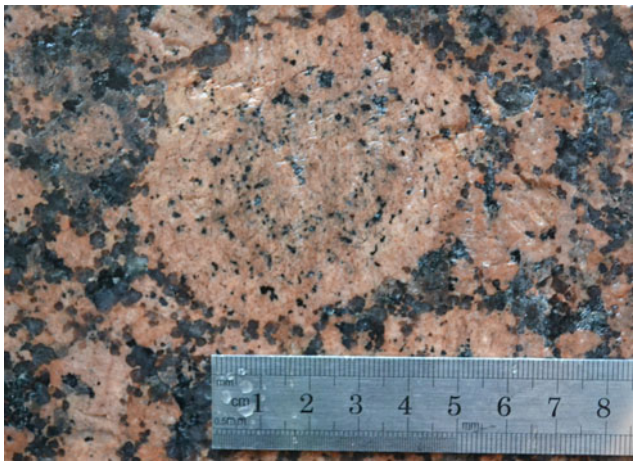

Fig. 2.41 Porphyritic granite with ovoids (monument to I.V., V.G., N. V. Kusovs in the Necropolis of the 18th century)

Tombs of gray, fairly homogeneous fine- and medium-grained, medium- and coarse-grained rocks are very common in the museum Necropoleis (Fig. 2.46). They often demonstrate a banded texture, which is manifested in the alternation of strips and lenses of different mineral composition and structure. The rocks look very much alike from the outside. The research identified granites, gneiss-granites, granite-gneisses, diorites and gabbros among them.

Mineralogical and petrographic study of F.A. Vlasova's gravestone showed that the rock consists of feldspars (predominantly), quartz and mica (Fig. 2.47). There are slightly elongated tabular crystals of acid plagioclase 0.2–0.8 mm, sometimes up to 1.5 mm in size. Quartz is represented by isometric grains of 0.1–0.5 mm in size, rarely—up to 2 mm, mica (biotite)—by subparallel lamellar crystals of 0.1–0.8 mm in size. According to the results obtained, the examined gray

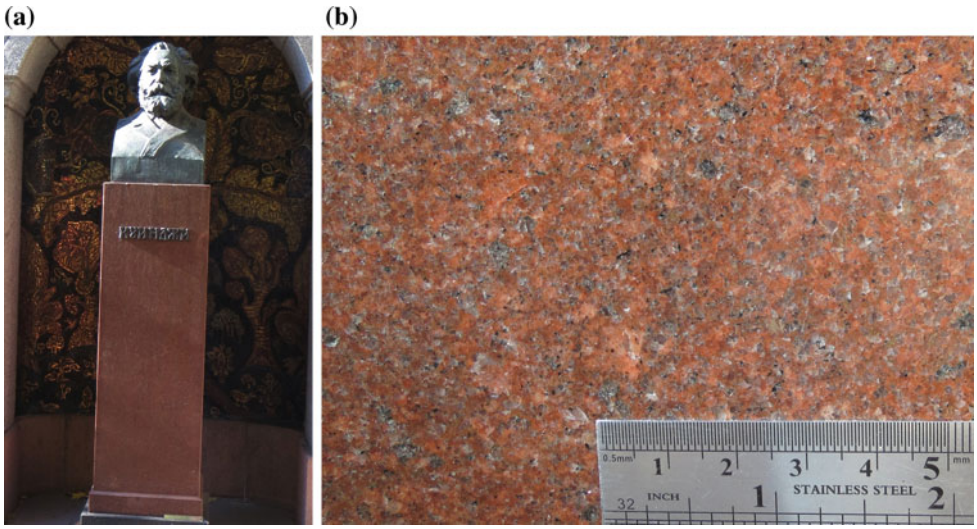

Fig. 2.42 Monument to A.I. Kuindzhi with a pedestal of brown-red fine- and medium-grained granite: **a** general view of the monument, **b** fragment of the rock

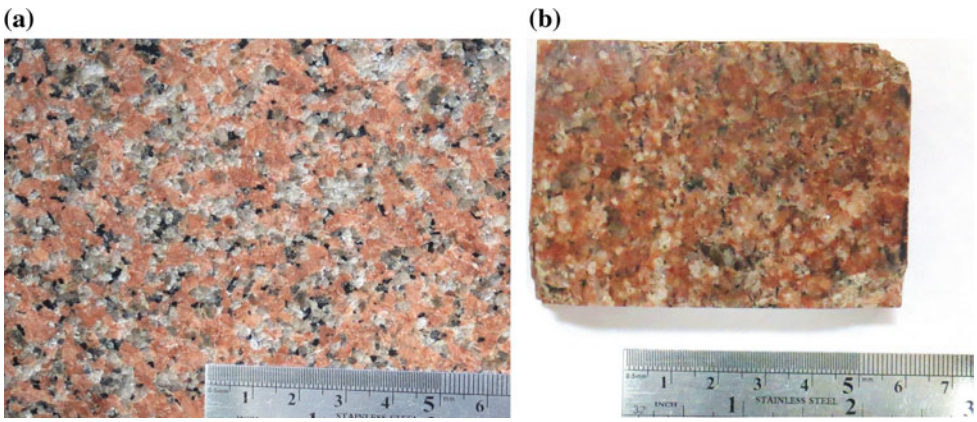

Fig. 2.43 Brown-red medium- and coarse-grained granite: **a** monument to I.A. Melnikov in the Necropolis of Masters of Arts, **b** the deposit (Island of Syskyjansaari)

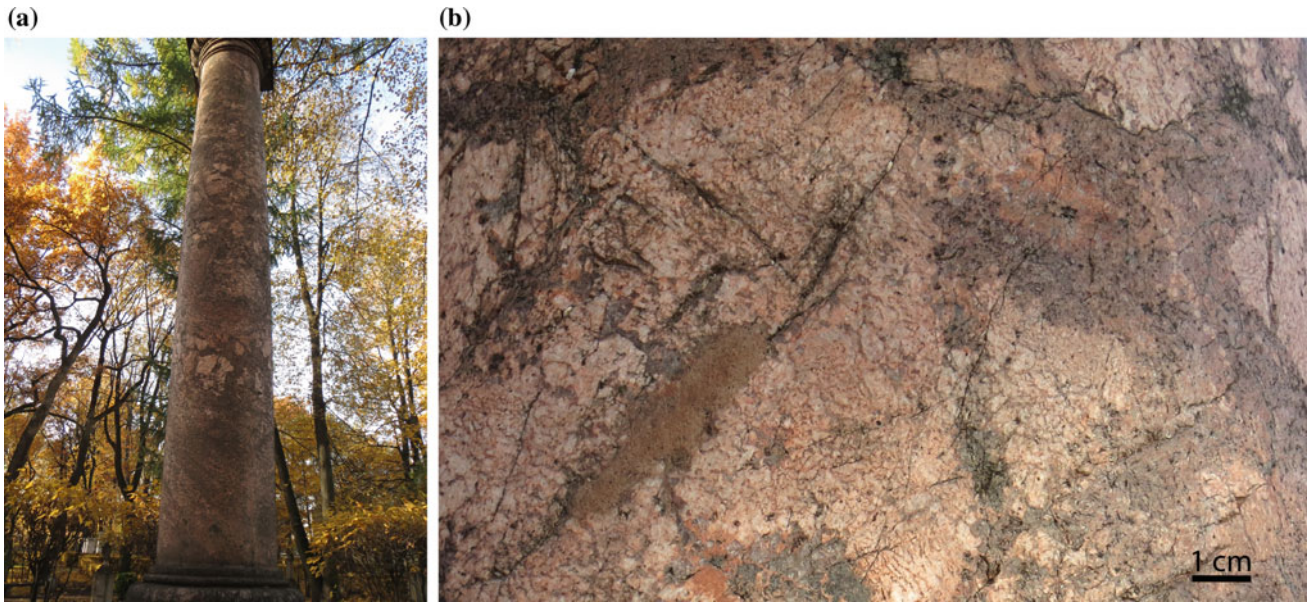

Fig. 2.44 G.A. Senyavin's column from brecciated granite: **a** general view, **b** fragment of the rock

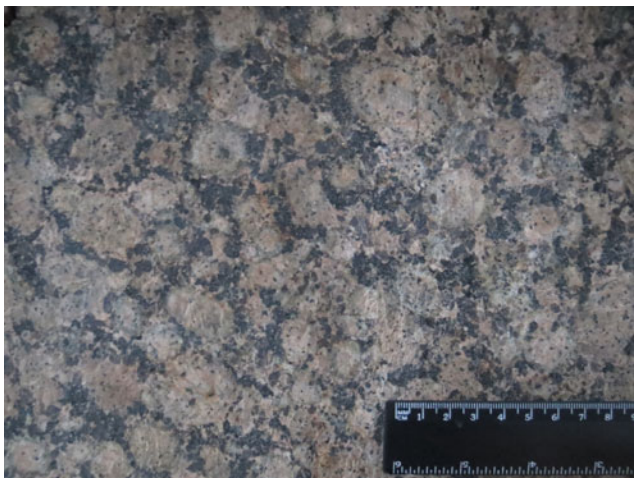

Fig. 2.45 Grayish pink ovoid granite (monument to M.I. Petipa)

Fig. 2.46 Gray homogeneous gneiss granite (monument to F.A. Vlasova)

fine- and medium-grained rock is gneiss-granite and, in its mineralogical and petrographic characteristics, is close to gneiss from the deposit near the village of Nukuttalahti and the town of Sortavala (Fig. 2.47b).

The results of the laboratory study of A.G. Kusheleva's and A.E. Egorov's gravestones showed that they are close to each other in terms of the mineral composition and structural features (Fig. 2.48).

Both are made up of fine- and medium-grained, sometimes porphyritic rocks, composed mainly of feldspar (basic plagioclase), pyroxene—to a lesser extent, also amphibole and mica. Plagioclase is represented by tabular, elongated crystals of 0.3–2.0 mm, sometimes up to 3 mm. Pyroxenes (diopside-augite) are represented by small isometric grains up to 1.5 mm, rimmed with amphibole (hornblende) and mica (biotite). In A.E. Egorov's gravestone microcline and quartz are present in very small amounts. In conformity with these data, the monuments to A.G. Kusheleva and A.E. Egorov are made of light-coloured gabbro.

Looking very much alike, these homogeneous, fine- and medium-grained rocks (gneisses, granites, granite gneisses, light-coloured varieties of gabbro), mined in Karelia near Sortavala (formerly called Serdobol), belong to the

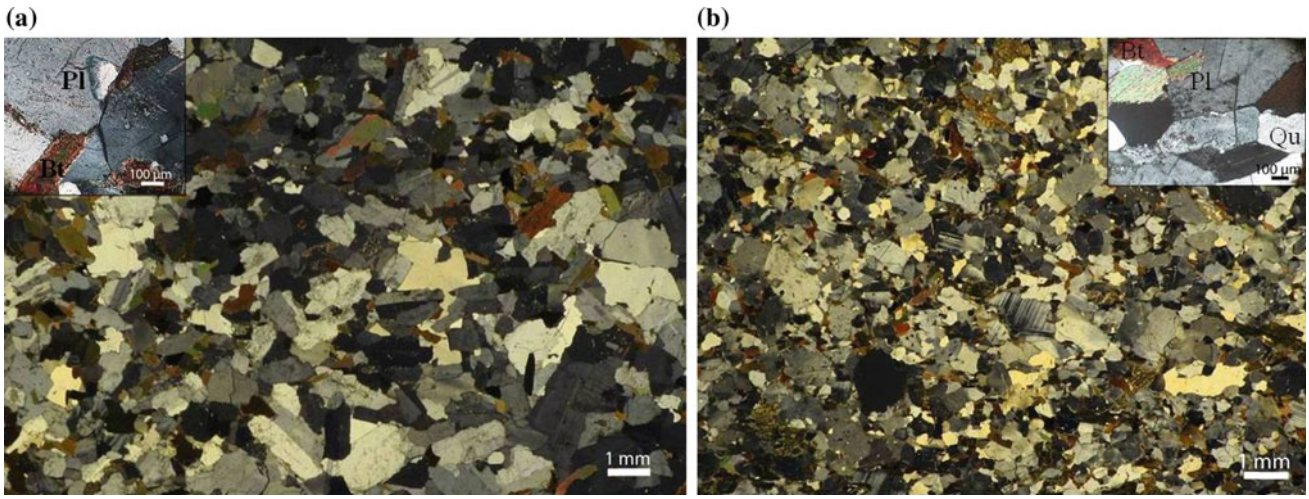

Fig. 2.47 Light microscope images (XPL) of the thin sections of gray gneiss-granite: **a** monument to F.A. Vlasova, **b** the deposit (Karelia, village of Nukkatalahti). Legend: plagioclase—Pl, mica (biotite)—Bt, quartz—Qu

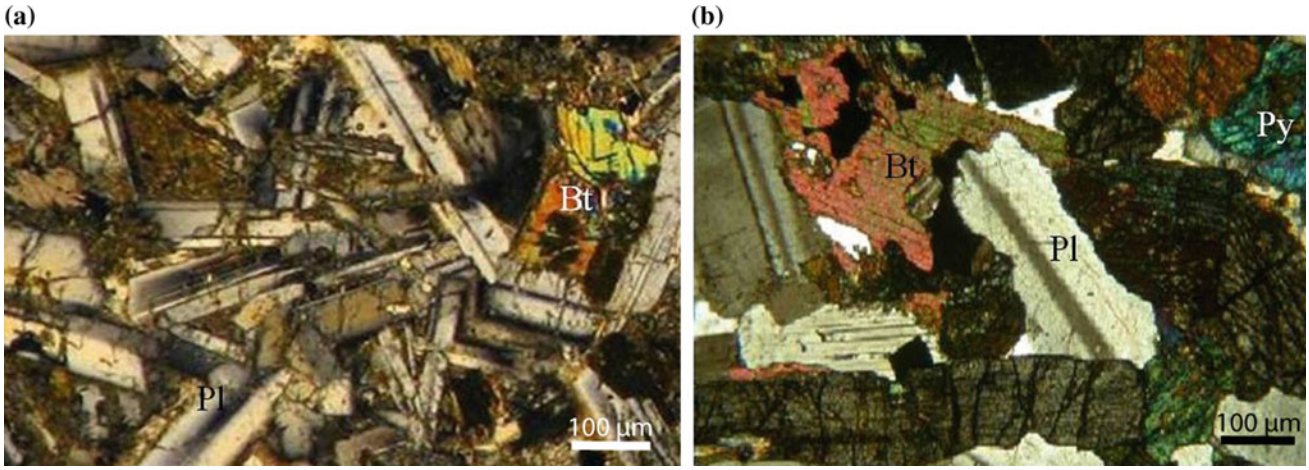

Fig. 2.48 Light microscope images (XPL) of the thin sections of light gabbro of the monuments: **a** to A.E. Egorov, **b** to A.G. Kusheleva. Legend: mica (biotite—Bt), plagioclase—Pl, pyroxene—Py

Impiniemi-Lavuatsaari complex (Geologiya 2000). Historically, these rocks are commonly called «Serdobol granites» (Borisov 2008b). They were quarried on the islands of Lake Ladoga. It is known that Serdobol granites were widely used in the construction of St. Petersburg. Probably, the stone for most of the tombs of the Necropolis of gray uniform fine- and medium-grained rocks was mined in the quarries in the Sortavala area.

Much less common in the Necropolis are dark-colored (when polished—black or dark gray) rocks of gabbro type, from which the memorials to I. Musin-Pushkin, L.I. Shestakova, M.I. Glinka, M.A. Balakirev are carved (Fig. 2.49). It is known that these are equigranular fine crystalline rocks consisting of basic plagioclase and pyroxene (Ziskind 1989). The gabbro type rock is quarried in Karelia near Sortavala, and in the Leningrad Region.

The tomb of N.I. Utkin in the Necropolis of Masters of Art is made of *dark gray-green dense, fine- and medium-grained silicate rock with poorly manifested banding* (Fig. 2.50).

The laboratory study showed that the rock is mainly composed of amphibole, feldspars and quartz (in a subordinate amount) (Fig. 2.51a). Amphibole is represented by tabular and isometric crystals of hornblende. The grain size varies from 0.5 to 2 mm, sometimes reaching 3 mm. In the intergrowth with hornblende, relicts of pyroxene grains and chain sphene grains are observed. Plagioclase (andesine) is present in the form of tabular and isometric crystals

Fig. 2.49 Monument to I. Musin-Pushkin from gabbro-type rock

0.2–0.4 mm in size, quartz—as small xenomorphic grains and ingrowths in hornblende. According to the results of the study, it was established that the rock is amphibolite, similar in mineralogical and petrographic features to the amphibolite from the quarry on the island of Syskyjansaari (Karelia) (Fig. 2.51). Further research should answer the question whether there are other monuments of amphibolite in the museum Necropoleis.

Amphibolites are widespread in Karelia, in particular in the Sortavala area, where Serdobol granite is mined (Borisov 2008b). Usually they do not form large deposits. There are cases when amphibolite was mistaken for a darker variety of Serdobol granites.

Monuments made of *garnetiferous gneiss—a mottled rock with various phenocrysts (up to 10 cm in diameter) of crimson garnets—almandines* make the Necropoleis look very graceful (Fig. 2.52). Segregated banding of dark-colored minerals and garnets is clearly visible (Fig. 2.53). Garnetiferous gneiss was used for the monument to S.S. Botkin, as well as for pedestals of the monuments to P.V. Kindyakov, P. I. and E.S. Meshcherskys, P.I. Shubin and others.

The petrographic research of the material of S.S. Botkin's monument showed that this medium- and coarse-grained rock is a quartz-feldspar aggregate containing a substantial amount of mica (biotite). Garnet grains, intergrown with quartz, reach 3 mm in diameter in the thin section. Feldspar is represented by acid plagioclase (Fig. 2.54). Most likely, the stone was brought from the Ladoga area, where the outcrops of this rock are found (Borisov 2007; Baltybaev et al. 2009).

A notable place in the Necropolis of Masters of Art is occupied by the monument to I.R. Tarkhanov, sculpted to the design made by his wife E.P. Tarkhanova-Antokolskaya. The stone material of the monument is a very beautiful *greenish-gray medium- and coarse-grained porphyritic rock with large lathlike crystals of feldspar* (Fig. 2.55).

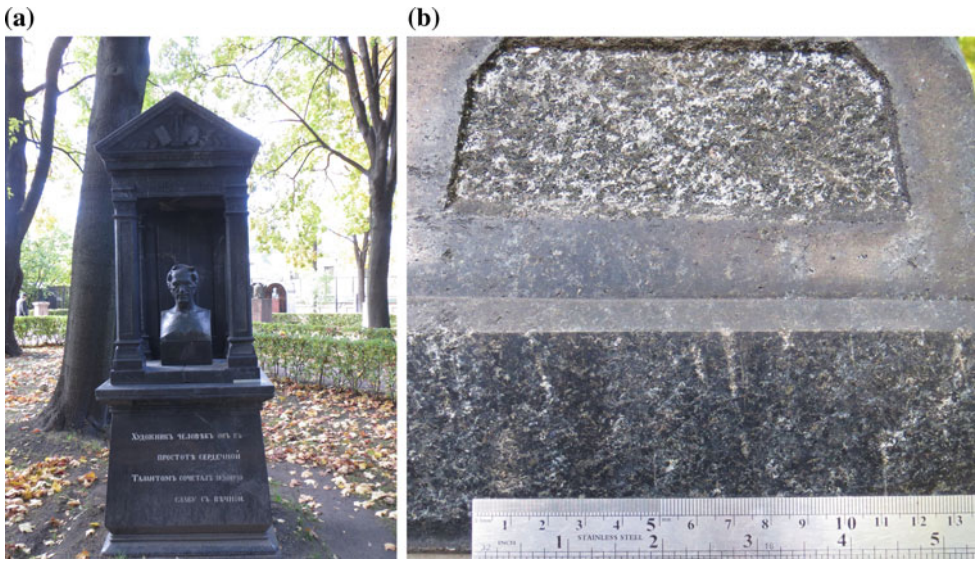

Fig. 2.50 Monument to N.I. Utkin from amphibolite: **a** general view of the monument, **b** fragment of the rock

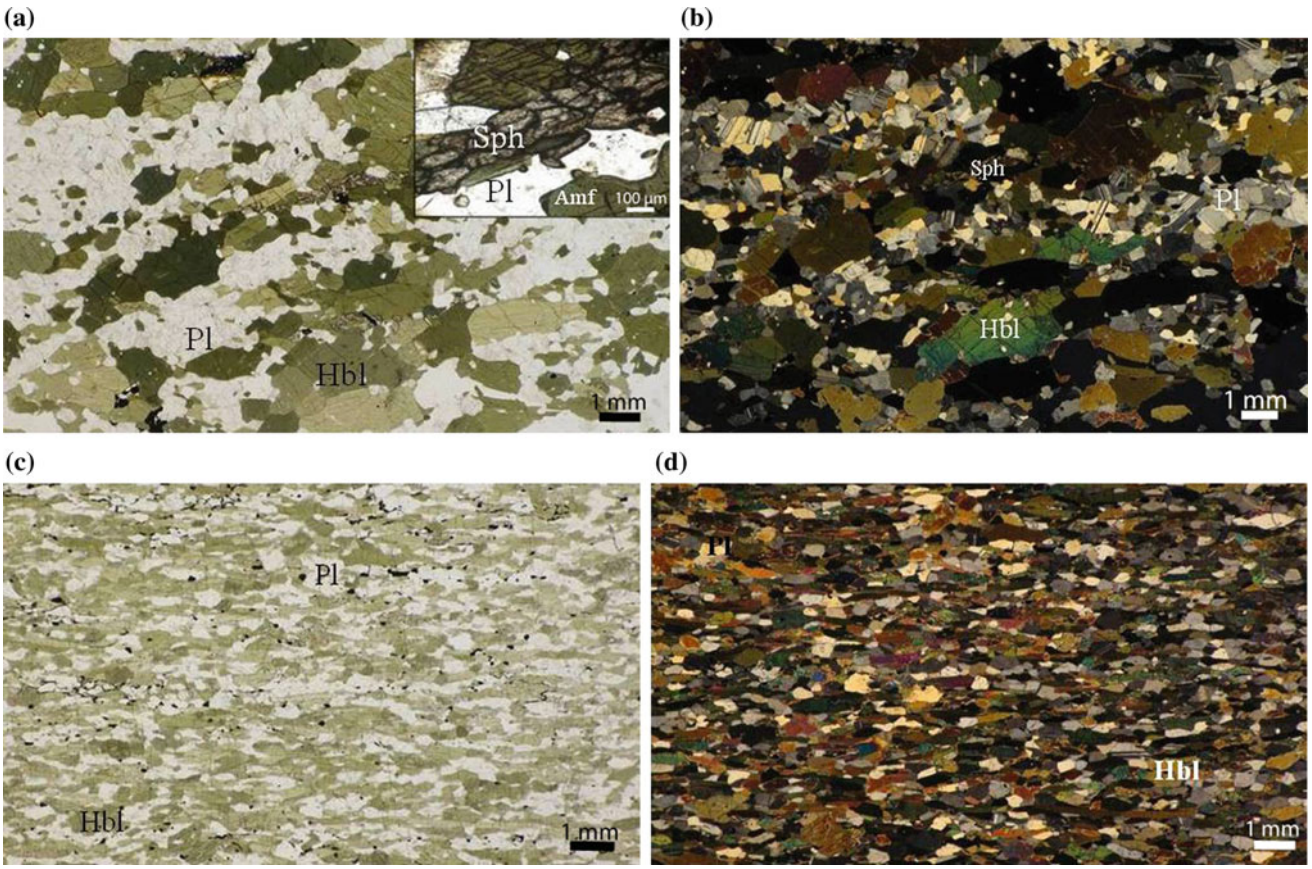

Fig. 2.51 Light microscope images of the thin sections of amphibolite from the monument to N.I. Utkin in the Necropolis of Masters of Art (**a**, **b**) and from the island of Syskyjansaari (**c**, **d**): **a**, **c** PPL; **b**, **d** XPL. Legend: amphibole (hornblende-Hbl), plagioclase-Pl, sphene-Sph

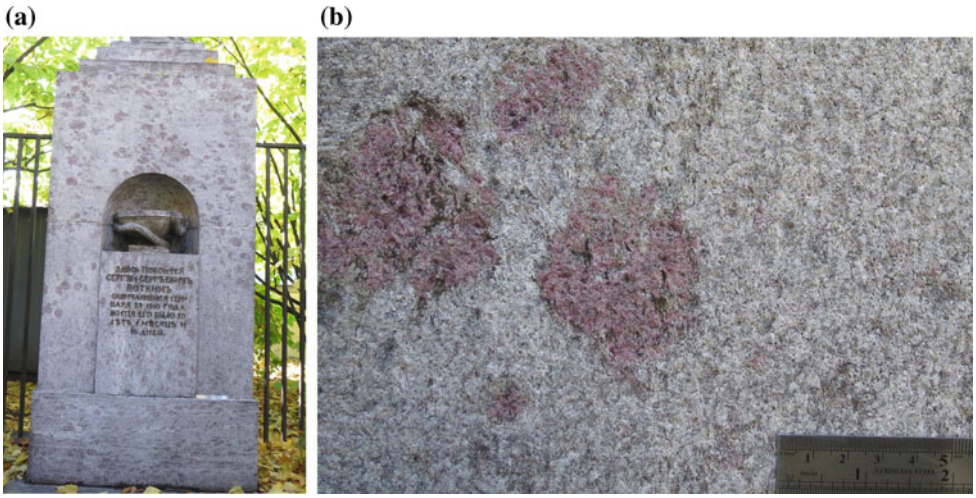

Fig. 2.52 Monument to S.S. Botkin from garnetiferous gneiss: **a** general view of the monument, **b** fragment of the rock

According to the results of the mineralogical and petrographic study, the rock consists almost entirely of basic plagioclase (Fig. 2.56). Pyroxene (probably diopside), biotite and quartz are present in small amounts. Plagioclase is represented by large (up to 12 mm) lathlike and tabular crystals, pyroxene—by small (up to 0.3 mm) tabular and isometric crystals, and biotite—by lamellar crystals (up to 0.8 mm). There are also grains of an ore mineral, possibly magnetite. Between the grains there are segregations of acid plagioclase. The obtained results proved that the examined

Fig. 2.53 Fragment of garnetiferous gneiss rock (monument to P.I. Shubin)

rock was anorthosite—the rock of the gabbro group, almost entirely composed of plagioclase.

Another rock among the most beautiful ones in the Necropoleis, labradorite, is practically a monomineral rock of the gabbro group composed of basic plagioclase, Labrador spar. From this rock the stele of V.F. Komissarzhevskaya's tomb in the Necropolis of Masters of Art (Fig. 2.57) was made. Thanks to the iridescence of feldspar (the sheen on the dark surface), labradorite is a valuable decorative stone. There is no information on the source of labradorite in the Necropolis in the archives of the Museum of Urban Sculpture.

The hardest rock in the Necropoleis is quartzite, *a homogeneous dense rock of red, crimson-red colour* (Fig. 2.58). Quartzite was used in the manufacture of decor elements, pedestals and sarcophagi. In the Necropolis of the

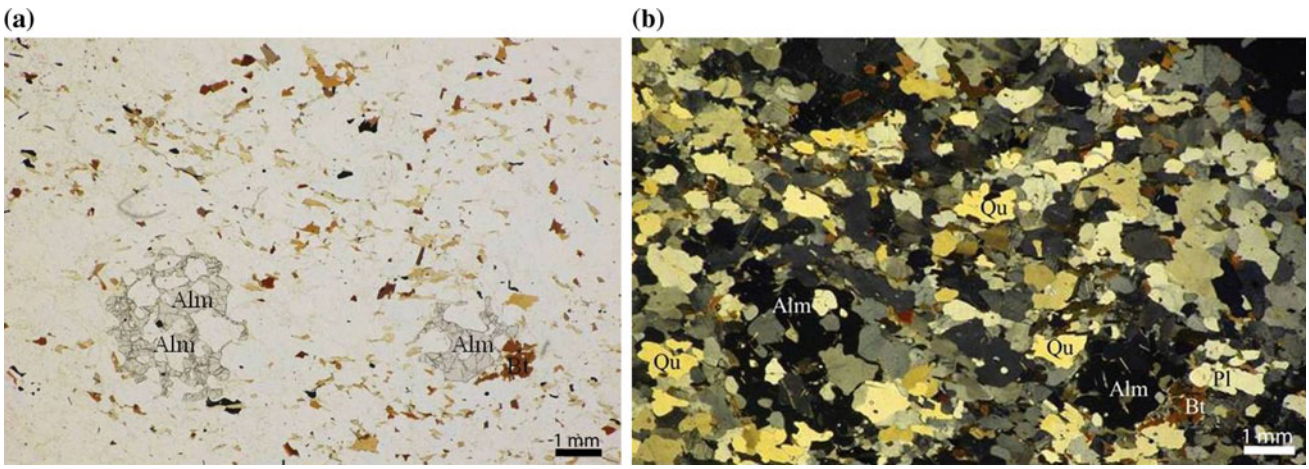

Fig. 2.54 Light microscope image of the thin section of garnetiferous gneiss (the monument to S.S. Botkin): **a** PPL; **b** XPL. In the biotite-quartz-feldspar mass phenocrysts of almandine garnet can be seen

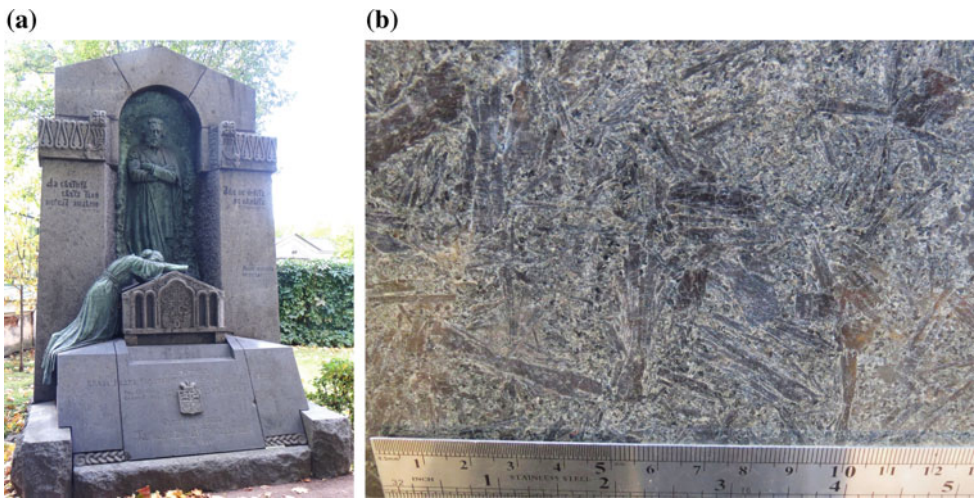

Fig. 2.55 Monument to I.R. Tarkhanov from anorthosite: **a** general view of the monument, **b** fragment of the rock

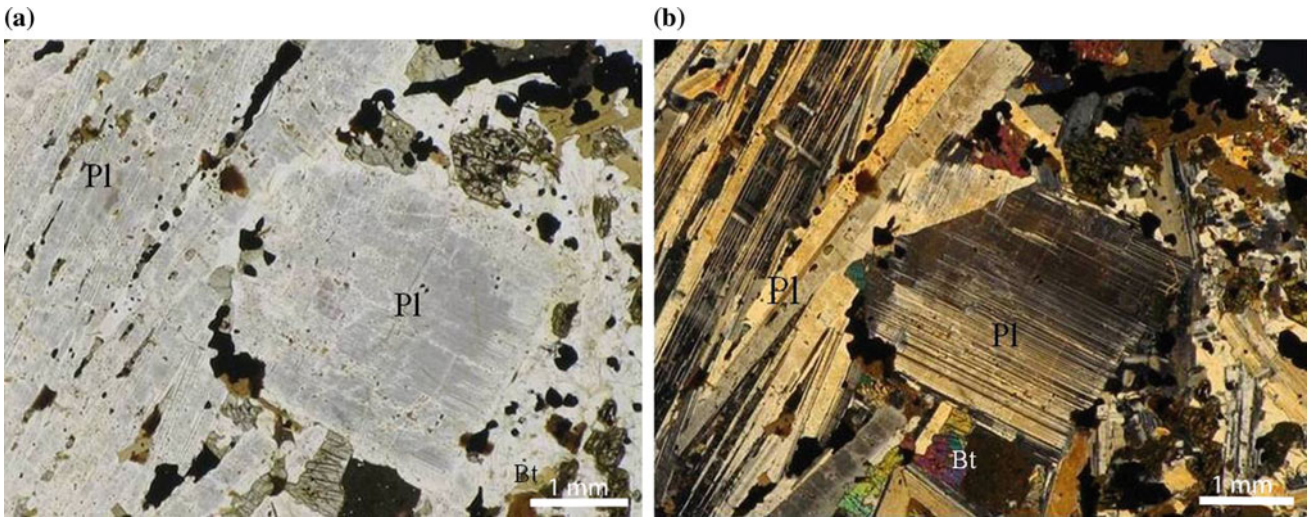

Fig. 2.56 Light microscope images of the thin section of anorthosite (the monument to I.R. Tarkhanov and E.P. Tarkhanova-Antokolskaya): **a** PPL; **b** XPL. The rock is almost entirely composed of large tabular and lathlike crystals of plagioclase (Pl). Small grains of biotite (Bt) can be seen

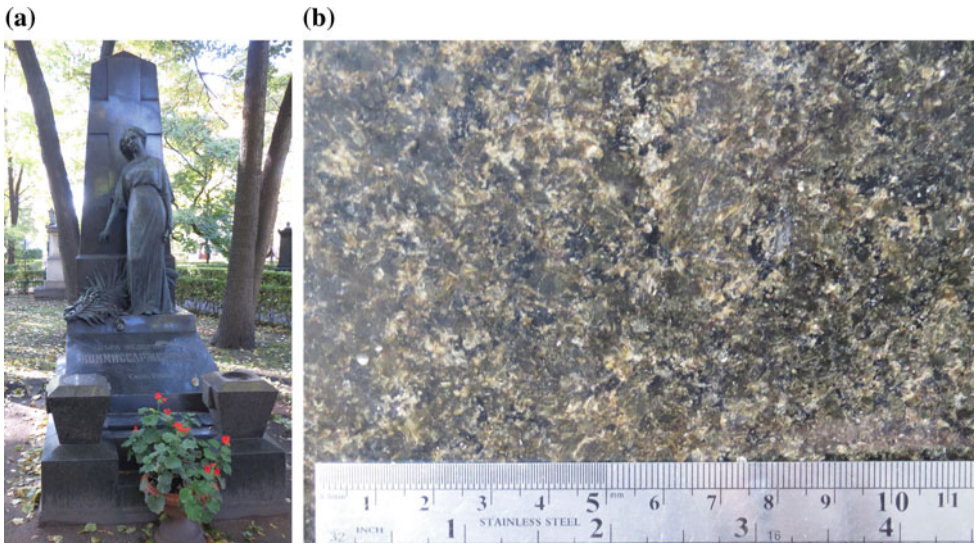

Fig. 2.57 Monument to V.F. Komissarzhevskaya with a stele from labradorite: **a** general view of the monument, **b** fragment of the rock

18th century. Details of the monuments to A.V. Skrypitsyn, A.F. Turchaninov, P.M. Arsenyev, N.S. Nertovskaya and others are made of this stone. The laboratory studies of the stone of A.F. Turchaninov's and the Unknown's tombs (N-18 No. 959) showed that it is a monomineral aggregate, composed of different-sized isometric quartz grains (0.05–1.50 mm) (Fig. 2.59). The crimson-red colour of the rock is due to the presence of iron oxides and hydroxides in the intergranular space.

The unique existing Shokshinskoye field of brightly colored crimson quartzites is located to the south of Petrozavodsk on the shore of Onega Lake (Ziskind 1989). Mining of Shokshinsky quartzites began at this deposit as far back as the 18th century. Outwardly, this stone resembles the famous porphyry from Egypt, and that is why in the old days it was often called "shohan porphyry" (Bulakh 2006). The pedestal of the monument to Nicholas I on St. Isaac's Square is made of it.

Fig. 2.58 Urn from red quartzite (the monument to A.V. Skrypitsyn in the Necropolis of the 18th century)

Thus, the diverse stone material in the museum Necropoleis is represented by marbles, limestones, granites and other hard rocks (gneisses, gabbroids, amphibolites, quartzites). To complete the picture, it is necessary to mention that in the Necropoleis there are also tombstones, separate parts of which are made of slate, and in the Necropolis of the Masters of Arts there is a monument to I.V. Tartakov, made of quartz sandstone. The results of observations, mineralogical and petrographic characteristics, archival data and published materials made it possible to ascertain the sources of stone supply to the Necropoleis, with varying degrees of reliability and detail. Basically, the stone came from Italy and the areas close to St. Petersburg (from the territory of the present Leningrad region, Karelia and Finland).

The museum Necropoleis are not inferior to the historical center of St. Petersburg in the variety of stone. Among the monuments there are unique ones (to N.A. Rimsky-Korsakov, I.R. Tarkhanov, etc.) made of stone, which has not yet been found anywhere else and whose origin is unknown.

The obtained characteristics of stone materials of the memorials are entered in the «Database on the state of the sculptural monuments in St. Petersburg» (www.opticalcomponents.ru). The data on the sources of stone supply for the tombstones serve and will continue to serve as indispensable information for restoration work.

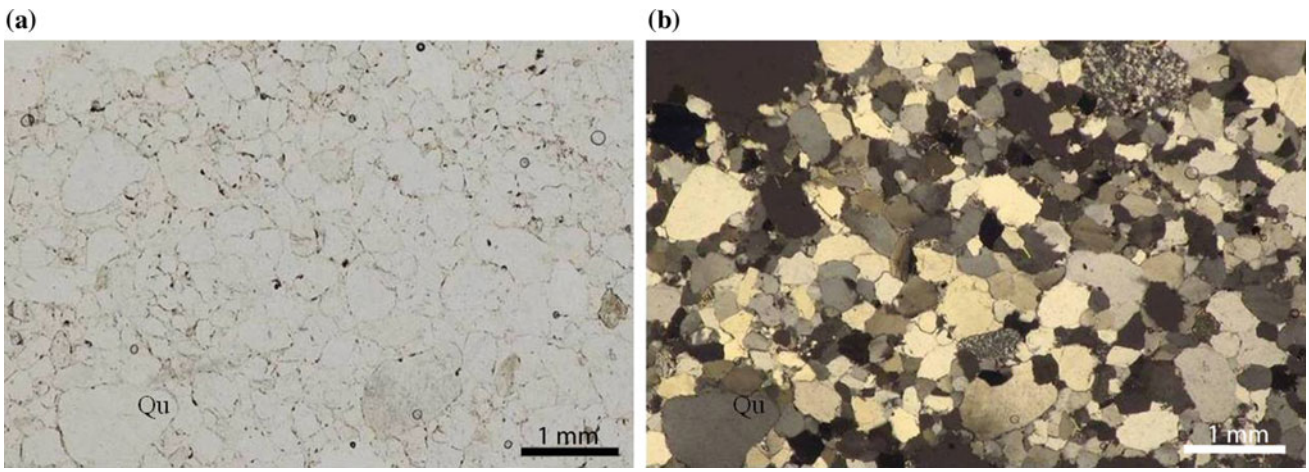

Fig. 2.59 Light microscope image of the thin section of Shokshinsky quartzite of the monument to the Unknown (N-18 No. 959): **a** PPL; **b** XPL

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