Salzburg building and ornamental stones — tradition and the present

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Most people around the world consider Salzburg, the birthplace of W.A. Mozart, as Mekka of classical music[3]. But many visitors are also astonished by extraordinary architecture and historical monuments decorated with specific natural stones. Salzburg appears to have, apart from its music tradition, a rich historical heritage of using famous local building and decorative stones through many centuries.

Like in many old cities, the image of Salzburg is stamped by the availability of stone material in its surrounding. Salzburg was a rich city for more than two thousand years due to important salt mines in the vicinity. Since the Middle Ages, it was an important religious and political centre in the middle of Europe. Therefore, "the most beautiful Italian city north of the Alps" (as Salzburg is recommended traditionally as exceptional tourist destination) was, for a long time, a trendsetter regarding architecture and fashion of stone usage for wide neighbouring regions. The Salzburg marbles were exported since the Middle Ages as far as Poland and Lithuania, but this interesting topic would require separate consideration.

When the Romans widely introduced stone masonry, Salzburg was in the lucky position to have plenty of various building materials directly at hand in its surrounding: limestones for mortar, conglomerates for building stones, and high quality "marbles" for decoration. Geologically, Salzburg is located at the northern rim of the Northern Calcareous Alps, within a basin (Fig. 1) overprinted by glacial activity during the latest ice ages. As a result, parts of the city hills are composed of Mönchsberg Conglomerate which has been intensely exploited as building material for monasteries, churches, palaces and fortifications for many centuries (Fig. 2).

The **Mönchsberg Conglomerate** is a kind of "natural concrete" of dark grey to brownish colour (Fig. 3). It is composed of numerous medium- to coarse-grained gravel in a sandy matrix, glued by carbonate cement. In fresh condition, the conglomerate is colourful, with gravel components of various limestones, gneiss, greenstone and quartzite, but weathering generates a dark grey to brownish patina. The conglomerate was formed as delta sediments within glacial lakes (kames) at the end of an ice age (Husen van, 1981) — its assumed age is middle Pleistocene but not well documented (Del-Negro, 1983).

The material was quarried since the Roman times till the middle of the 20th century. Nearly all steep rock walls along the so called city mountains are former

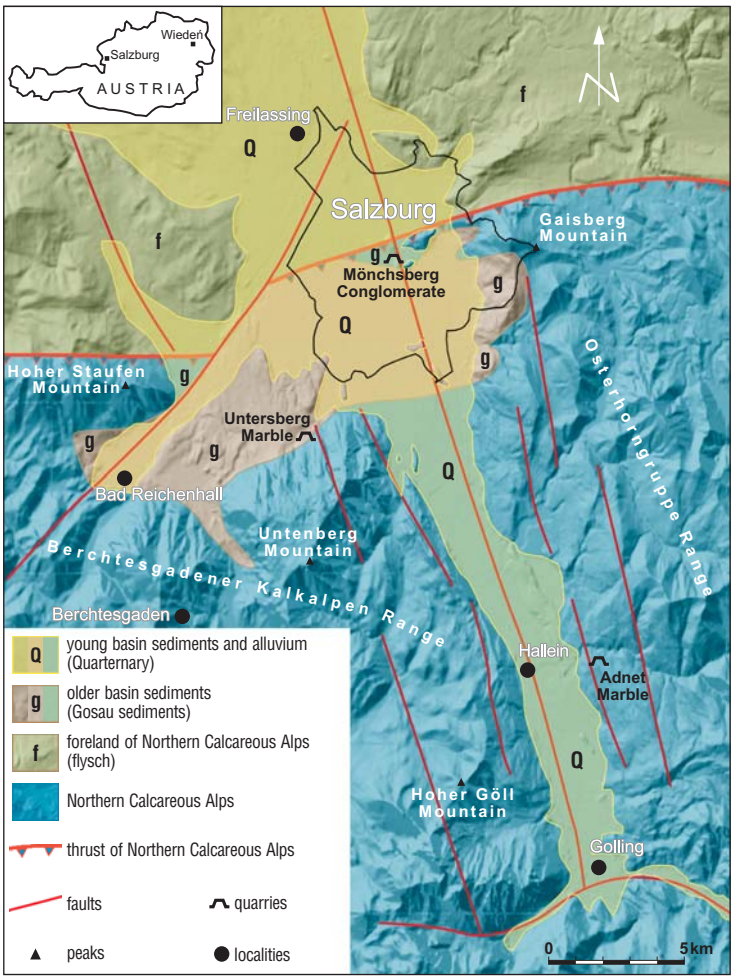

Fig. 1. Geological and morphological sketch of the Salzburg area showing quarries of the building and decorative stones. Compiled by C. Uhlir

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[3]This article is English version of the paper *Kamienie budowlane i dekoracyjne z Salzburga — tradycja i teraźniejszość* published in *Przegląd Geologiczny*, vol 58, nr, 4, pp: 472–479.

Fig. 2. Southern side of the Salzburg Cathedral made of Mönchsberg Conglomerate. Photo by R. Kryza

quarries. Naturally, abandoned quarries have been incorporated in the city development: steep rock faces for fortification and, more recently, abandoned quarries as a festival hall (*Felsenreitschule* of the Salzburg Festival House; Fig. 4) and an open air theatre (Hellbrunn) (Uhlir & Vetters, 2009). All sacral and civil monuments, fortifications, bridges and patrician houses built before 1948 were made of Mönchsberg Conglomerate. Most prominent examples are the Gothic Franciscan Church (Fig. 5), the Hohensalzburg Fortress and the Nonnberg Monastery.

The colourful Untersberg and Adnet marbles (these are in fact unmetamorphosed limestones, rather than marbles sensu stricto) have been used as decorative material for

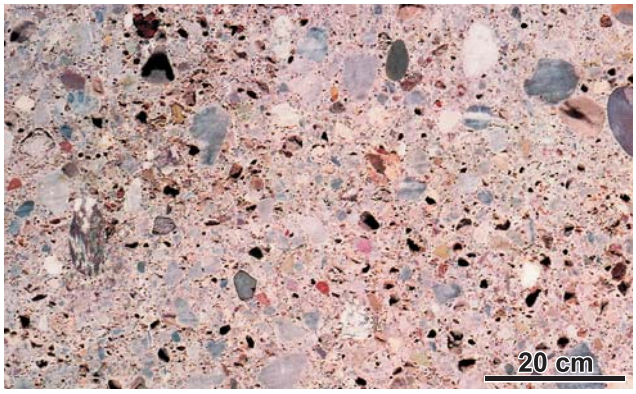

Fig. 3. Slab of Mönchsberg Conglomerate. Photo by C. Uhlir

Fig. 4. Salzburg Festival House within an abandoned Mönchsberg Conglomerate quarry. Photo by Tourismus Salzburg

architectural elements like portals, columns, flooring, façades, as well as for sculptures, fountains, grave stones and sacral elements in churches, e.g. epitaphs, altars and baptisteries (Kieslinger, 1964).

The **Untersberg Marble** occurs along the northern slopes of Mount Untersberg south of Salzburg (Fig. 1). This mainly arenaceous, but also conglomeratic and brecciated limestone was deposited in the Gosau Sea during the Late Cretaceous. Various older limestones of the Calcareous Alps were crushed by the breakers of the Gosau Sea to provide detrital material for the Untersberg Marble. The beach (littoral) sand and debris, as well as lateritic soil and clay, were removed by successions of marine slides, deposited at the continental shelf and cemented with fibrous calcspar. Today the deposits consist of sequence of 1–3 m thick beds with a total thickness of 30 m (Uhlir & Danner, 2008).

The limestone material varies bed by bed, and laterally within the beds, with grain size and content of reddish soil and clay (Fig. 6). The Untersberg Light is a pale cream, fine-grained to fine-brecciated limestone frequently with small (1–3 mm) globules of lateritic soil ("trout marble"). The Untersberg Rose is a rose-gray to rose, fine-grained limestone coloured by fine dispersed lateritic soil, often with bioturbation structures (burrows). The Untersberg Yellow is a rose-yellow to grey-yellow limestone, with a higher content of fine dispersed clay, therefore significantly softer than the others. The Untersberg Breccia is a colourful breccia, partly conglomeratic limestone, with a sandy matrix and clay rims around coarser components. All varieties have a pore volume as low as granite (0.25 %) and most of them are highly weathering-resistant (except Untersberg Yellow and Untersberg Breccia). The stone within the banks can be very uniform, which allows produ-

Fig. 5. Columns of Mönchsberg Conglomerate; interior of the Gothic Franciscan Church in Salzburg. Photo by R. Kryza

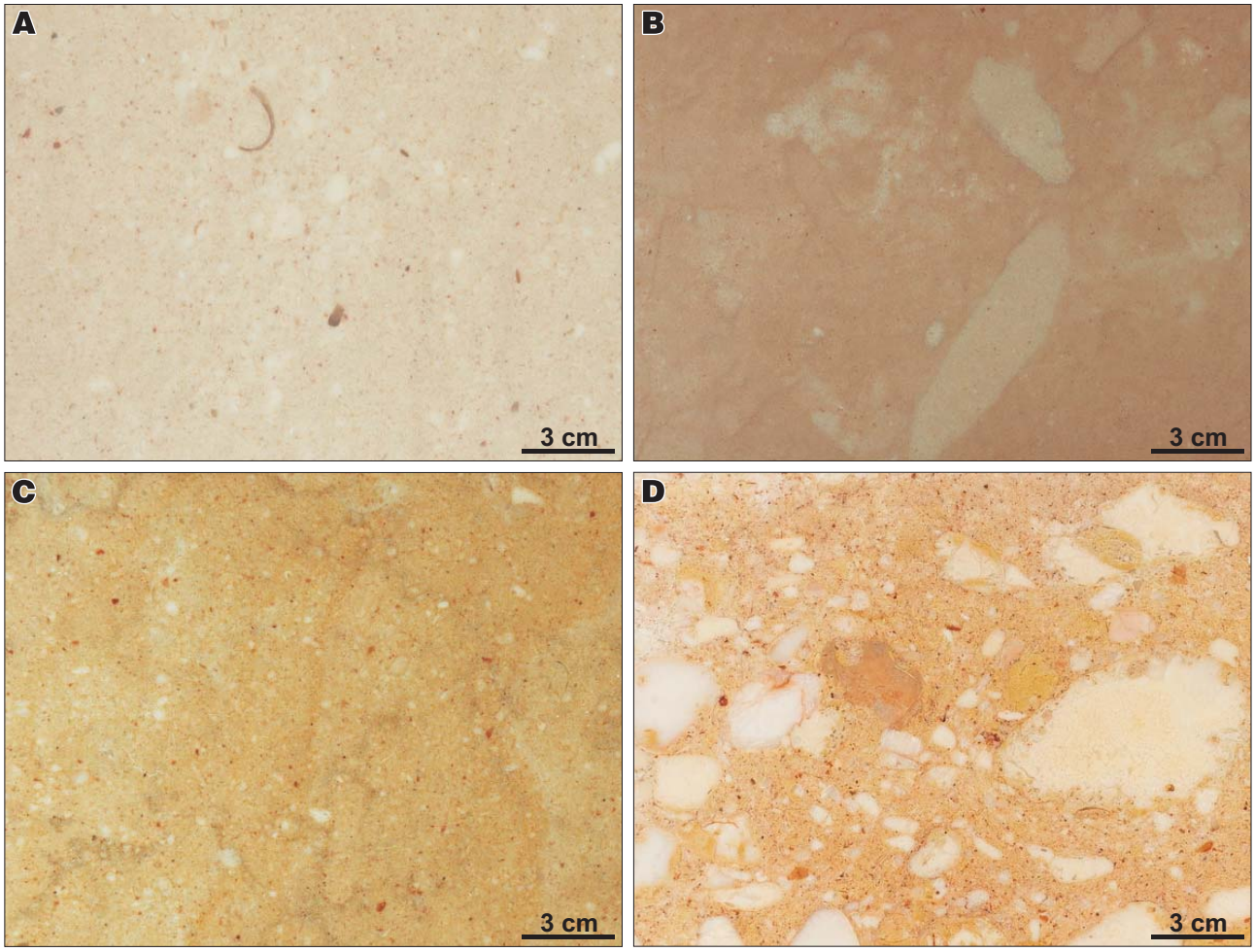

Fig. 6. Varieties of the Untersberg Marble. **A** — Untersberg Light ("trout marble"); **B** — Untersberg Rose; **C** — Untersberg Yellow; **D** — Untersberg Breccia. Photo by C. Uhlir

cing monolithic blocks (for columns and large sculptures) of up to 10 m in size.

The Untersberg Marble has been quarried more or less continuously for two thousand years now, earlier within two and recently within three quarry complexes (Fig. 7). Already the Romans used the material extensively for monuments, grave stones, façades of temples and administrative buildings in the radius of 200 km. After a period of reuse of Roman material in the early Middle Ages, the use of Untersberg Marble had a boom during the Renaissance and Baroque times — it was the main material for statuaries over a large region. In the 19th century, the quarries were a private property of the Bavarian Royal Dynasty, therefore the main palaces and administrative buildings and fountains in Munich are made of the Untersberg Marble. During the Wilhelminian Period (1871–1918), it was used for all types of architectural elements (Kieslinger, 1964). Untersberg Marble was used as exterior decorative material for façades (portals, columns), fountains and sculptures and as interior stone for flooring, columns and stairs. Most prominent examples are the façade of the Salzburg Cathedral, the Residence Fountain (Fig. 8) and the Raphael Donner staircase in the Mirabell Palace. Also in modern architecture (Salzburg Museum and Natural Science Faculty of the Salzburg University), Untersberg Marble is used for façades and flooring.

The **Adnet Marble** occurs at the village of Adnet near the town of Hallein, south of Salzburg (Fig. 1). The term Adnet Marble covers a large variety of limestones of the calcareous Alps:

a) Upper Triassic (Rhaetian) reef and reef debris limestone, with beautiful fossil corals embedded in a matrix of various colours (Fig. 9A; Flügel & Tietz, 1971; Bernecker et al., 1999);

b) Lower Jurassic (Hettangian) shallow marine gray to dark red limestone, with needles of sponge, parts of crinoids and algae (stromatolites);

c) Lower Jurassic (Sinemurian) deep marine brown to red-brown, nodular limestone with fossils of ammonites and frequent Fe-Mn coatings and crusts; (Fig. 9B and C belong to the Lower Jurassic Adnet Group; Böhm et al., 1999; Böhm, 2003);

d) Lower Jurassic (Pliensbachian) limestones of submarine mud flows, having white calcspar fillings between red nodules (Böhm et al., 1995).

The Rhaetian reef limestones (Tropf and Urbano) vary in thickness up to 250 m. The Adnet Tropf Marble is a coral limestone with colour variations of the matrix from cream, grey, green and violet to red-brown (Fig. 9A). The Urbano Light Marble is a reef talus, containing parts of coral and bivalve (99.5 % calcium carbonate). The Lower Jurassic limestones form successions of a few metres to 20 metres

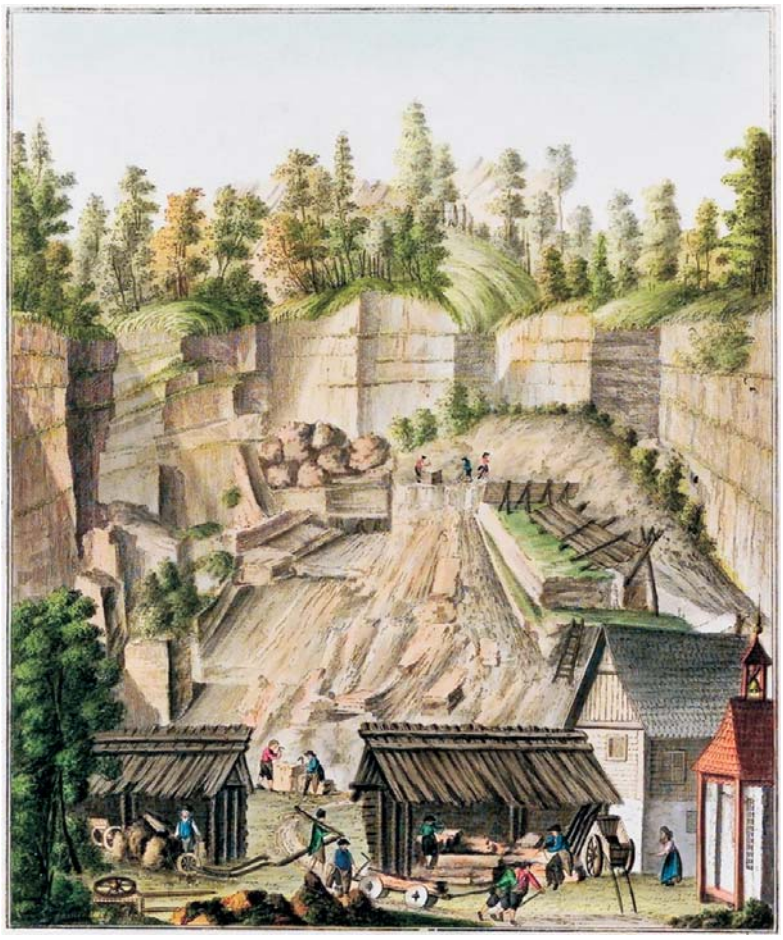

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Fig. 7. Lithography of the Hof Quarry in 1792; Franz von Naumann. Photo by Untersberg Museum

thick. Frequently, two or more variations are found in one quarry. The Schnöll Marble (Fig. 9C) is a massive grey to red limestone with white fossils of sponges and crinoids. The Lienbacher Marble (Fig. 9D) is a thick-bedded nodular pale brown-red limestone with light coloured nodules, with few Fe-Mn hydroxide crusts. The Wimberger Marble (Fig 9E) is a thin-bedded nodular brown red to gray limestone with Fe-Mn rims around the nodules and frequent clay-rich Fe-Mn hydroxide crusts between 5 to 20 cm thick layers (Fig. 10). The Adnet Scheck (Fig. 9F) is a massive, gray to red limestone with white calcspar fillings between the nodules.

Two main types can be distinguished among the Adnet stones: the massive marble and the nodular bedded marble, the latter with higher contents of Fe-Mn compounds and clay along crusts and clay around nodules. The nodular, partially sheared limestone is less weathering-resistant than the massive varieties. Long time exposure can lead to complete disintegration of the rock (Schweigl & Neubauer, 1997). Features distinguishing the Adnet nodular limestone from the Veronesa Rosso or Hungarian Red are frequent, round bleaching zones of 1 to 3 cm diameter around dark grey core minerals.

The Adnet Marble has been quarried continuously since the early Middle Ages within a "quarry landscape" of about 1 km^2 size, with 23 quarry complexes. The strange names of the stone varieties are names of the farmers who owned and operated the quarries till the end of the 19th century (Kieslinger, 1964). Extensive use and material export started in the Gothic times for the production of epitaphs. During the Renaissance and

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Fig. 8. Residence Fountain in Salzburg; the upper bowl of the fountain is made of one piece of Untersberg Marble. Photo by C. Uhlir

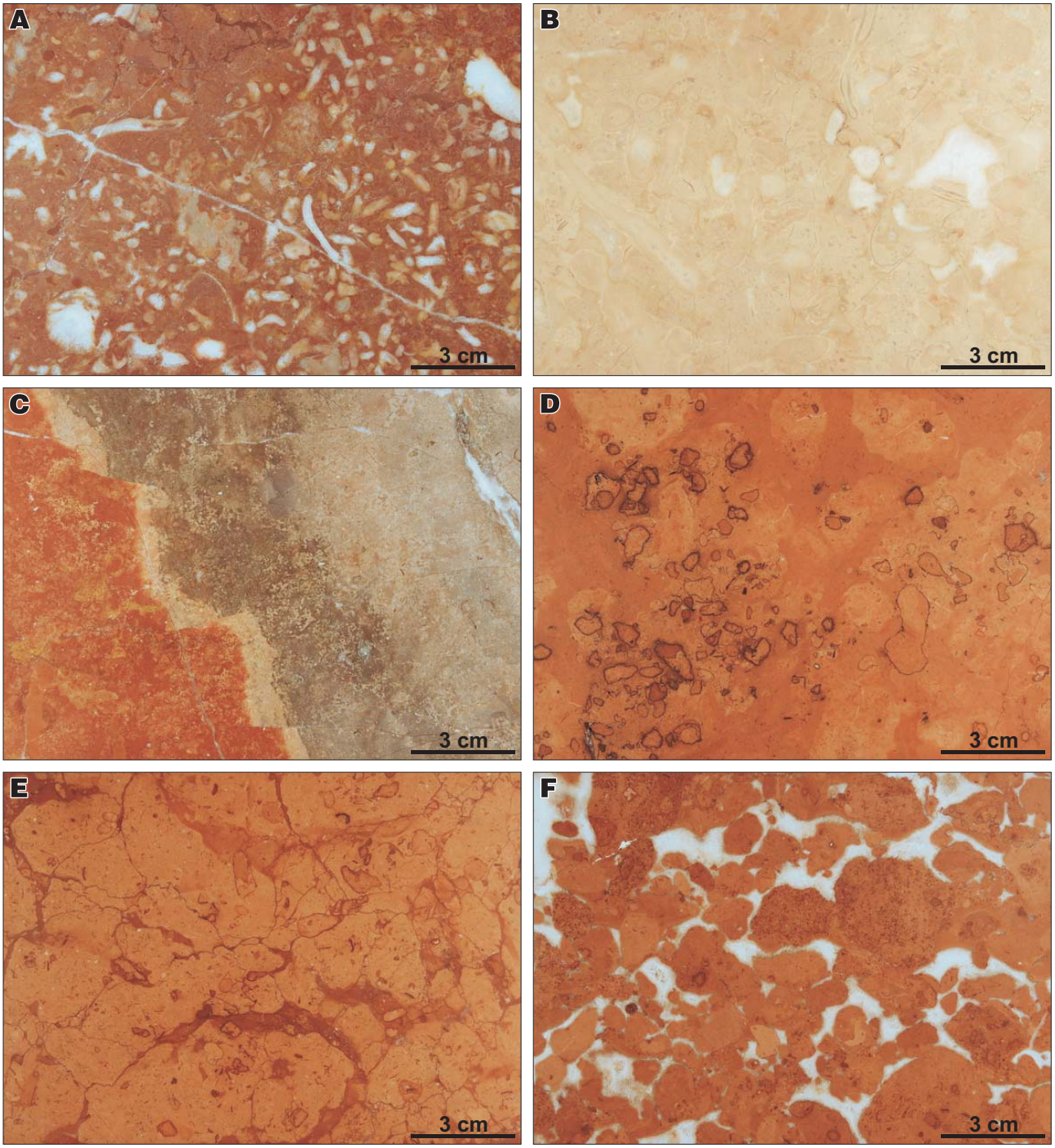

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Fig. 9. Varieties of the Adnet Marble. **A** — Adnet Tropf; **B** — Urbano Light; **C** — Schnöll Marble; **D** — Lienbacher Marble; **E** — Wimberger Marble; **F** — Adnet Scheck ("paint horse") Marble. Photo by C. Uhlir

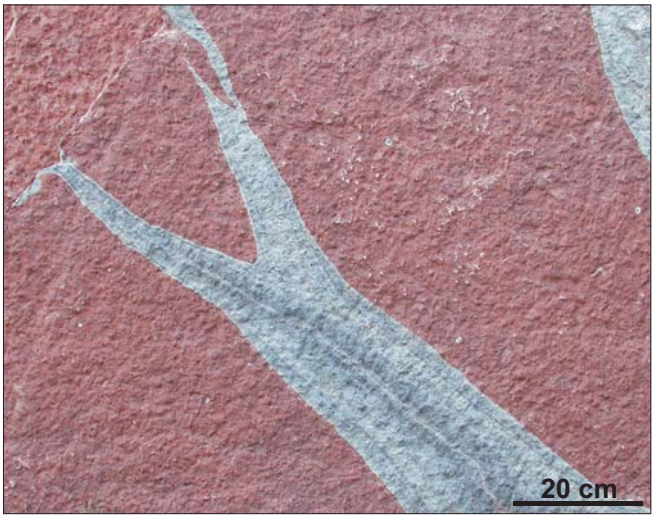

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Fig. 10. Wimberger Marble with frequent zones of bleaching. Photo by C. Uhlir

Fig. 11. Fragment of the late Gothic monument of the Archbishop Leonhard von Keutschach at the Hohensalzburg Fortress; Lienbacher Marble. Photo by C. Uhlir

Fig. 12. Fragment of epitaph at St. Peter Church in Salzburg; Adnet Marble. Photo by R. Kryza

Fig. 13. Marbles Adnet Scheck (red) and Untersberg (pale pink) in balustrade of an attached chapel of the Cathedral in Salzburg. Photo by R. Kryza

Baroque, huge blocks where exported for grave monuments and a mass production of altars and baptisteries started (Figs. 11–13). During the Wilhelminian Period, the order book of the main company in Adnet may be read like a *Who is Who* of Central Europe (Uhlir, 2008).

The most prominent uses of the Adnet marble are Gothic epitaphs, found in churches and cemeteries of Salzburg. Massive Gothic columns were used in the fortress of Salzburg, and Baroque columns — in the Toskana Wing of the Salzburg Residence. Of importance are also the large Monument of Archbishop Leonhard von Keutschach (Fig. 11) and the sarcophagus of colonel Hans Werner von Raitenau in the St. Peter Church.

After the World War II, there has been a major decline in the quarry industry as well as in stone manufacturing crafts in the Salzburg region. Quarrying for the Mönchsberg Conglomerate ended entirely, and the production of the Untersberg and Adnet marbles slowed down by abandoning a lot of individual quarries.

Currently, only five small quarries are being operated in Adnet deposits. The material is mined for manufacturing slabs, for flooring and secular indoor decoration and, partly, for restoration works. In August 2010, a thematic museum dedicated to the Adnet Marble will be opened in the village of Adnet.

At the Untersberg deposits, the Kiefer Quarry is still active. Since 1995, a part of the Mayr Melnhof Quarries has been re-opened, using underground extraction technologies. Today the material is mined mainly for manufacturing slabs, for flooring and façades, and randomly used by statuaries. Since 1960, the summer academy of sculptors has been arranged annually at the Kiefer Quarry.

More recently, we can observe a general run on investment in natural resources in Austria, including the traditionally important Untersberg and Adnet quarry districts near Salzburg.

This study has been inspired by CEEPUS Network CII-AT-0038-04-0809 — *Geosciences in Central and South-Eastern Europe*.

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Manuscript received May 9th, 2009.
Revised manuscript accepted April 14th, 2010.