

# Aflenz

Aflenzer Sandstein

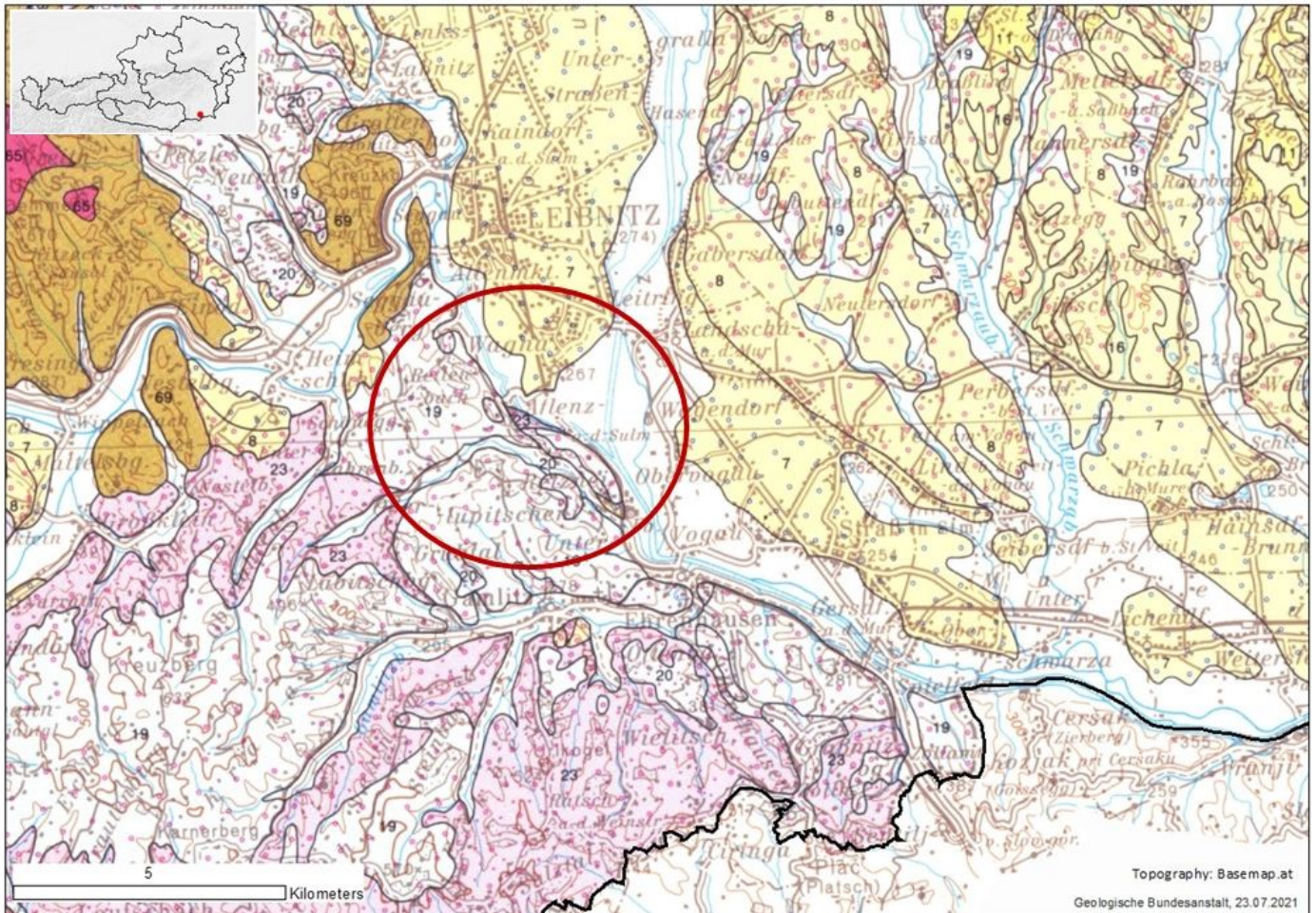
Aflenzer Muschelkalk



**Short description:** light yellow, almost white, porous arenitic limestone composed mainly of coralline algal debris and foraminifers with occasional large bivalve (oyster) shells, bryozoans, rhodoids, coral-clasts, marly streaks, non calcareous mineral particles

| Commodity<br>(vocabulary) | Lithology<br>(vocabulary) | Typical<br>colour<br>(code list) | Place of origin |                                 |                             |                         |
|---------------------------|---------------------------|----------------------------------|-----------------|---------------------------------|-----------------------------|-------------------------|
|                           |                           |                                  | Country         | County / District /<br>Province | Municipality /<br>Community | Place/town /<br>Village |
| Commercial<br>Sandstone   | Calcarenite               | Beige                            | Austria         | Leibnitz/Steiermark<br>(Styria) | Aflenz an der Sulm<br>Wagna | Aflenz an der Sulm      |

# Geological setting



**Geology:** The occurrence at Aflenz is one of several isolated areas of fossiliferous, often bioclastic limestones, influenced by fine grained terrigenous material and volcanic ashes on former highs and margins in the Parathethys subbasin in southern Styria (white signature with red dots on the map, 20). Part of the structured coralline algae platforms with coral bioherms and coral and rhodolith carpets are wedges of coralline calcarenites accumulated as submarine dunes, the Aflenz Sandstone. It is regarded a Leitha Limestone variety.

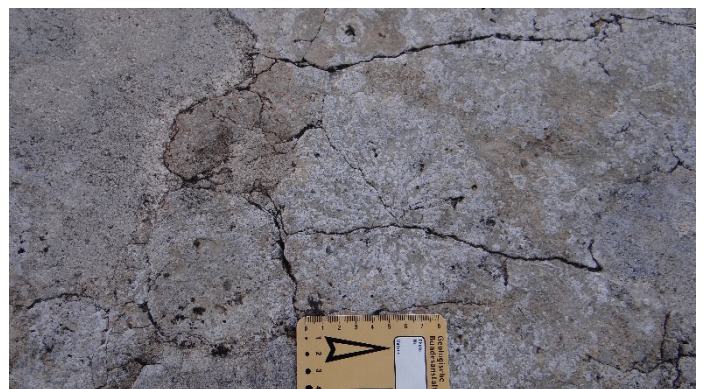
**Production:** The main quarrying area is located around the village of Aflenz (red marking). The limestone has been quarried since Roman times, partly in large underground caverns. The central underground quarry measures about 300x200 m and is between 6 and 8 m high, stabilized by a grid of remaining pillars. To the southeast follows the Retznei mining area, where the material is used for a cement plant.

**Geological age:** Badenian - Sarmatian

**Geological unit:** Weissenegg Formation (URI: <http://resource.geolba.ac.at/GeologicUnit/924>)

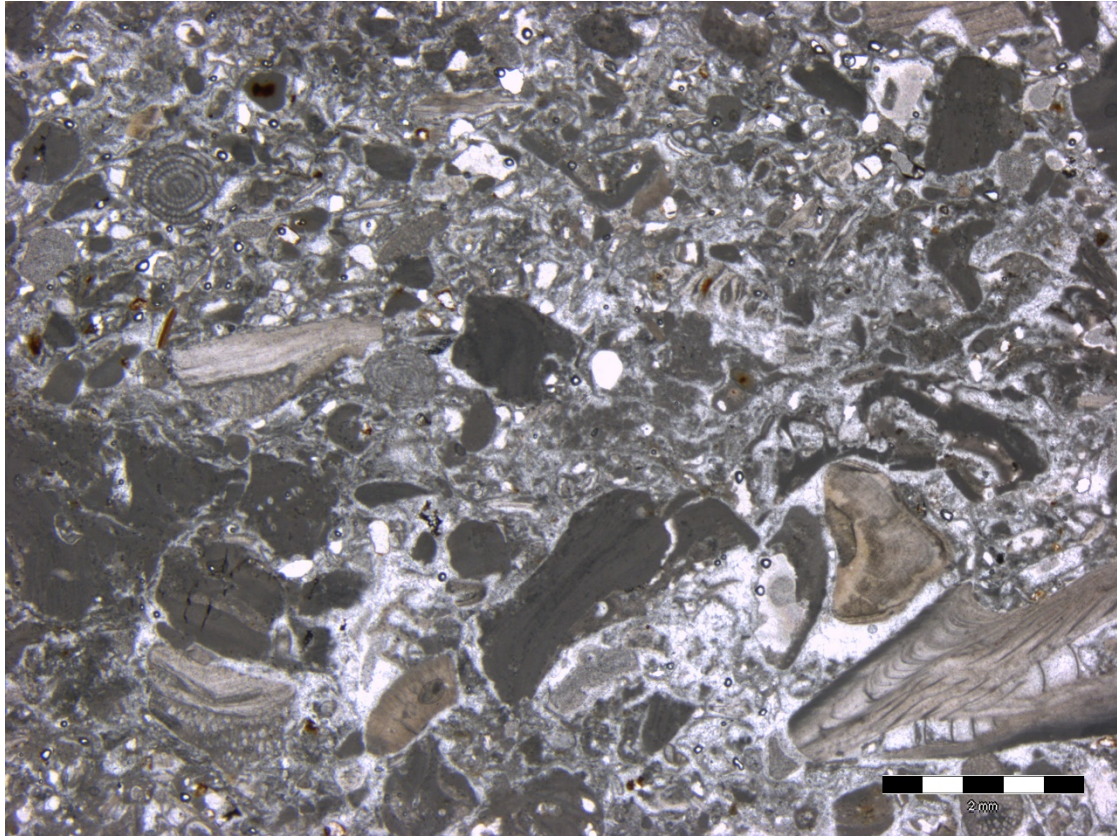
# Application, use and heritage

**Description:** The material has been used since the 1st century AD, e.g. for the Roman amphitheatre in Flavia Solva. In the Middle Ages it was used for the construction of Seggau Castle, in the 16th century for the Graz Landhaus, in the 17th century for the mausoleum for Emperor Ferdinand II in Graz. The Karl Franzens University, the Technical University and the Herz Jesu Kirche in Graz are also built of Aflenz stone. The stone was increasingly used in the 19th century for numerous buildings on Vienna's Ringstraße. After the Second World War, Aflenz stone was mainly used for restoration purposes - examples include Vienna's St. Stephen's Cathedral, Vienna State Opera, Belvedere Palace and Graz Castle.



**Description:** examples of the use of Aflenz limestone (and its varieties) in historic buildings in Graz: top left: inner courtyard of the Graz Landhaus built in the Renaissance; top right: Herz Jesu Kirche built in the Baroque; bottom left: vestibule of the neo-baroque Graz Opera House; bottom right: kerbstone from driveway of the Old Technical University made from a marly rhodolith limestone from the Leithakalk limestone successions west and north of Aflenz

# Petrography



**Description:** picture from binocular, non polarized light; porous and weakly cemented, arenaceous, mixed carbonatic-siliciclastic packstone with highly fractured bioclasts; red algae particles in dark olive brown, larger lighter brown fragments are from oyster shells and crustaceans; white spots are quartz, but also open pores

**Source of information:** Bednarik et al., 2014

# Mineral composition

If no accurate number, use MM=main minerals, SM = Subordinate minerals, AM=accessory minerals

|           |  |  |  |  |  |  |
|-----------|--|--|--|--|--|--|
| Calcite   |  |  |  |  |  |  |
| <b>MM</b> |  |  |  |  |  |  |
|           |  |  |  |  |  |  |
|           |  |  |  |  |  |  |

**Source of information:**

# Physical properties

| Apparent density (EN 1936) kg/m <sup>3</sup> | Open porosity (EN 1936) % vol | Water absorption at atmospheric pressure (EN 13755) % wt | Uniaxial Compressive strength (EN 1926) MPa | Flexural strength under concentrated load (EN 12372) MPa |
|----------------------------------------------|-------------------------------|----------------------------------------------------------|---------------------------------------------|----------------------------------------------------------|
|                                              |                               |                                                          |                                             |                                                          |

| Real density (EN 1936) kg/m <sup>3</sup> | Total porosity (EN 1936) % vol | Water absorption coefficient by capillary (EN 1925) (g/m <sup>2</sup> x s <sup>0,5</sup> ) | Flexural strength under constant moment (EN 13161) MPa |
|------------------------------------------|--------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------|
|                                          |                                |                                                                                            |                                                        |

| Frost resistance (EN 12371)                                 |                  |                                                                        |                  |                                                                                    |
|-------------------------------------------------------------|------------------|------------------------------------------------------------------------|------------------|------------------------------------------------------------------------------------|
| Technological Test (Test A)                                 |                  |                                                                        |                  | Identification Test (Test B):<br>Number of cycles completed prior to stone failure |
| Flexural strength (EN 12372) after freeze-thaw cycling, MPa | Number of cycles | Uniaxial compressive strength (EN 1926) after freeze-thaw cycling, MPa | Number of cycles |                                                                                    |
|                                                             |                  |                                                                        |                  |                                                                                    |

| Resistance to ageing by thermal shock (EN 14066)                     |                                                      |                                                                  |                                                                           |
|----------------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------------|
| Change in dynamic modulus of elasticity (increase: +; decrease: -) % | Change in open porosity (increase: +; decrease: -) % | Change in ultrasound pulse velocity (increase: +; decrease: -) % | Change in flexural strength under conc. load (increase: +; decrease: -) % |
|                                                                      |                                                      |                                                                  |                                                                           |

| Abrasion resistance (EN 14157)          |                                                                     |                                     | Resistance to salt crystallisation (EN 12370) | Breaking load at dowel hole (EN 13364) |                                     |
|-----------------------------------------|---------------------------------------------------------------------|-------------------------------------|-----------------------------------------------|----------------------------------------|-------------------------------------|
| Method A - Wide Wheel Abrasion Test, mm | Method B - Böhme Abrasion Test, cm <sup>3</sup> / 50cm <sup>2</sup> | Method C - Amsler Abrasion Test, mm | Change in mass (increase: +; decrease: -), %  | Breaking load, N                       | Thickness of the test specimens, mm |
|                                         |                                                                     |                                     |                                               |                                        |                                     |

| Slip resistance by means of the pendulum tester<br>(EN 14231 / CEN/TS 16165) |                             |                    | Rupture energy<br>(EN 14158),<br>Joule | Thermal Conductivity (EN<br>1745),<br>W/m·K |
|------------------------------------------------------------------------------|-----------------------------|--------------------|----------------------------------------|---------------------------------------------|
| Tested<br>surface<br>finish                                                  | Slip Resistance Value — SRV |                    |                                        |                                             |
|                                                                              | Dry test condition          | Wet test condition |                                        |                                             |
|                                                                              |                             |                    |                                        |                                             |

Source of information:

# Chemical properties

## Main elements

| SiO <sub>2</sub><br>(%) | Al <sub>2</sub> O <sub>3</sub><br>(%) | Fe <sub>2</sub> O <sub>3</sub><br>(%) | TiO <sub>2</sub><br>(%) | MgO<br>(%) | CaO<br>(%) | Na <sub>2</sub> O<br>(%) | K <sub>2</sub> O<br>(%) | MnO<br>(%) | P <sub>2</sub> O <sub>5</sub><br>(%) | SO <sub>3</sub><br>(%) | LOI<br>(%) |
|-------------------------|---------------------------------------|---------------------------------------|-------------------------|------------|------------|--------------------------|-------------------------|------------|--------------------------------------|------------------------|------------|
| 0,90                    | 0,10                                  | 0,15                                  | 0,01                    | 0,79       | 53,8       | 0,07                     | 0,02                    | 0,01       |                                      | 0,05                   | 43,8       |

## Trace elements

| V (ppm)  | Cr (ppm) | Mn (ppm) | Co (ppm) | Ni (ppm) | Cu (ppm) | Zn (ppm) | As (ppm) |
|----------|----------|----------|----------|----------|----------|----------|----------|
|          |          |          |          |          |          |          |          |
| Sr (ppm) | Cd (ppm) | Ba (ppm) | Pb (ppm) | Be (ppm) | Rb (ppm) | Bi (ppm) | U (ppm)  |
|          |          |          |          |          |          |          |          |
| Sc (ppm) | Y (ppm)  | Th (ppm) | Sb (ppm) | Ta (ppm) | Nb (ppm) | Zr (ppm) | Sn (ppm) |
|          |          |          |          |          |          |          |          |
| Ag (ppm) | B (ppm)  | Mo (ppm) | W (ppm)  | Ga (ppm) | Ge (ppm) | Se (ppm) | Cs (ppm) |
|          |          |          |          |          |          |          |          |
| Tl (ppm) |          |          |          |          |          |          |          |
|          |          |          |          |          |          |          |          |

## REE

| La (ppm) | Ce (ppm) | Pr (ppm) | Nd (ppm) | Sm (ppm) | Eu (ppm) | Gd (ppm) | Tb (ppm) |
|----------|----------|----------|----------|----------|----------|----------|----------|
|          |          |          |          |          |          |          |          |
| Dy (ppm) | Ho (ppm) | Er (ppm) | Tm (ppm) | Yb (ppm) | Lu (ppm) |          |          |
|          |          |          |          |          |          |          |          |

**Methods applied and source of information:** analysis of major and minor elements: energy-dispersive X-ray fluorescence analysis; gravimetric determination of the loss on ignition; Geological Survey of Austria (GBA)

## Sources of more information

| Type of information      | Name of provider                   | URL                                                                 |
|--------------------------|------------------------------------|---------------------------------------------------------------------|
| This data sheet          | Geological Survey of Austria (GBA) | <a href="https://www.geologie.ac.at">https://www.geologie.ac.at</a> |
| Non-commercial directory |                                    |                                                                     |
| Commercial directory     |                                    |                                                                     |
| Scientific publication   |                                    |                                                                     |
| Other publication        |                                    |                                                                     |

Bednarik, M., Moshhammer, B., Heinrich, M., Holzer, R., Laho, M., Rabeder, J., Unterwurzacher, M. & Uhlir, C. (2014): Engineering geological properties of Leitha Limestone from historical quarries in Burgenland and Styria, Austria.- Engineering Geology 176, pp. 66-78, Elsevier, Amsterdam.

Moshhammer, B. & Malecki, G. (Projektl.) (1994): Systematische Untersuchung von Rohstoffvorkommen zur Optimierung der Wertschöpfung.- Unveröffentlicher Bericht Projekt Ü-LG-025/88-93, 27 Bl., Anh. m. Karten 1:200.000, Geologische Bundesanstalt, Wien.

Picture of stone surfaces: Source: Kieslinger-Archive, Geological Survey of Austria, Wien.

Geological map: Joanneum Research GIS STMK (2009): GEOFAST Provisorische Geologische Karte der Republik Österreich 1:50.000 Blatt 207 Arnfels.- 1 Bl., Geologische Bundesanstalt, Wien.

Moser, M. (2016): GEOFAST Provisorische Geologische Karte der Republik Österreich 1:50.000 Blatt 190 Leibnitz.- 1 Bl., Geologische Bundesanstalt, Wien.

Topographic map: Basemap.at (<https://basemap.at>)

|                     |                                                                                                           |                                                                                                                      |
|---------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| <b>Compiled by:</b> | Geological Survey of Austria (GBA)<br><a href="https://www.geologie.ac.at">https://www.geologie.ac.at</a> |  <b>Geologische Bundesanstalt</b> |
|---------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|