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GRUBER'S KARST RESEARCH

GRUBERJEVO RAZISKOVANJE KRASA

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Abstract UDC: 551.44(091):929 Gruber G.

Stanislav Južnič: Gruber's Karst Research

On the bicentennial of Gabriel Gruber's death his speleological and karstological research in Carniola are described. Gruber carefully studied his predecessors' researches of Carniolan karst and Cerknica Lake in particular. He provided several new ideas in the joint work of Tobias Gruber and his older half brother Gabriel. For the first time in historiography Gruber's karstological references were discussed. The special concern was put on the Gruber's model of the stalactite formation where he proved his extraordinary abilities in Newton's modern mathematics. Very sad stories about Gruber-Hacquet quarrels were connected with their different opinions about karst.
Key words: Gruber, Hacquet, Carniola, speleology, larstology, Cerknica Lake, Timavo, stalactites.

Izvleček UDK: 551.44(091):929 Gruber G.

Stanislav Južnič: Gruberjevo raziskovanje krasa

Ob dvestoletnici smrti Gabrijela Gruberja smo opisali njegovo raziskovanje krasa, Cerkniškega jezera in reke Timav. Pojasnili smo, zakaj je številne nove Gabrijelove dosežke njegov mlajši polbrat Tobija objavil pod svojim imenom. Prvič v zgodovinopisju smo objavili popis citiranih del v Gruberjevih raziskavah krasa. Visoko smo ocenili Gruberjev opis kapnikov ter Cerkniškega jezera po analogiji s hidravličnimi stroji in Heronovim reakcijskim gorilnikom. Podrobno smo obravnavali Gruberjevo pismo o reki Timav. Obžalovanja vredni spor med Gruberjem in Hacquetom po letu 1775 smo skušali dodatno osvetliti z nasprotji pri njunem pojmovanju krasa.
Ključne besede: Gruber, Hacquet, Carniola, speleologija, krasoslovje, Cerkniško jezero, Timava, kapniki.

INTRODUCTION

Grubers were a wealthy Viennese armourer's family of Slovene origin. Gabriel Gruber's (1740-1805) younger half brothers Tobias (1744-1806), Johann Nepomuk (* 1746) and Anton Gruber (1750-1819) were also Jesuit mathematical scientists; that make them one of the most influential Slovene science family. They contributed a great deal to Carniolan karst research and also to the development of Ljubljanese mathematical sciences. Gabriel became one of the greatest Slovene scholars and politicians and his achievements certainly deserve a quick look.

G. Gruber devoted his life to the pedagogical, scientific, engineering, and political work in Ljubljana, Mogilev, Polock, and finally - Petersburg.

Place, time in Gregorian calendar	Professor (chair)	Naturalist	Engineer, architect	Politician
Ljubljana 4/6/ 1768-January 1785	Mechanics and hydraulics on higher studies; 8/4/1769 –1784 industrial school	Hydraulics 1781, 1784, and 1785; Optical mirages 1779, published 1787	Canal 9/3/1771 –10/12/1777; palace 1773-1783; villa Podrožnik 1775; Navigation director 4/6/1772-1/3/1781	Emperor's navigation councilor 8/4/1775-10/12/1777
Mogilev 1785/ 86	Mechanics			
Polock 1786-1800	Mathematics, physics, architecture, drawing, mechanics 1786-1800. In last classes of lower studies ballistics, pyrotechnic, military, and civil architecture	Magnets and earthquakes 1789 (published 1790)	Planed and built Jesuit college 1788	Assistant of the Jesuit general vicar 1797-1802
Mstislav 1787	Architecture			
Mogilev 1789	Architecture			
Vitebsk 1789	Architecture			
Livonia 23/8/ 1800-1805	Educational plan of Vilna university given to Gruber leadership in May 1801			
Petersburg 1801-1805	Rector of college 11/10/ 1800; experimental physics 13/2/1801-1805; six years educational plan in autumn 1802	Exhibition of mechanical tools in Russian academy in June 1799		Jesuit General 22/10/1802

Table 1: Gabriel Gruber's works in chronological order.

Figure 1: Gabriel Gruber (1740-1805).

On June 4, 1768, Gruber came to Ljubljana. Next year, he was appointed the head of the chair for drawing, geometry, mechanics, and hydraulics in the Jesuit College of Ljubljana. The Agricultural society of Carniola with the help of the Estates General kept Gruber on that chair until 1784, more than a decade after the suppression of the Jesuit Order. The students from as far as Venice attended his lessons at the department for shipbuilding.

Gruber directed the works on Ljubljana canal still called by his name and the navigation on the rivers Ljubljanica, Save, Drave, Mura, and Kolpa. In fact, he was in charge for inland sailing on all rivers in Habsburg monarchy except Danube. Between 1774 and 1777, he arranged for his half brother Tobias a similar job at Timisoara in Banat. In 1780, Tobias became the director of buildings on Bohemian cameral properties. From 1780 until 1800, he was a president of the Scientific Society of Bohemia in Prague with some interruptions. Gabriel and Tobias jointly wrote the letters with hydrographical and physical content to Baron Ignaz von Born (1742-1791), the court councilor, curator of the court natural historical cabinet in Vienna, and master of the most important freemason lodge in Vienna. Gruber addressed his first letter to the "dearest friend" Born. Tobias published the letters in 1781 with two later continuations. Gabriel was probably unwilling to sign his own works because he was the leading figure at the Jesuit secret diplomacy and on his way to became the General of the Jesuits.

In 1776 an 1778, Baltazar Hacquet de La Motte (1739/40-1815) also published his letters mailed to Born. After 1775, Hacquet publicly accused G. Gruber for unscientific methods, bad canal administration, and even alchemy (Hacquet, 1781 2: 9; Hacquet 1784, 3: 51, 151-153; Pilleri, Mušič 1984, 29; Švajgar 1996, 77). Gruber and Hacquet accepted different mineralogical ideas. Both were professors at the Lyceum of Ljubljana after 1773. Hacquet was not very popular in Carniola because of his sharp criticism of the clergy (SBL 1925-1932, 1: 268). In spite of their quarrels the Agricultural society of Carniola knew how to use the abilities of both, Hacquet and Gruber. Hacquet became a member and secretary of Society in 1772. On April 20, 1774 meeting, the Society's Board decided that Hacquet, Janez Nepomuk Giehl (* 1734), and Franc Mühlbacher (* 1744) should travel through

Carniola, note the natural wealth, its conceivable use and multiplicity, and gather the data for the political history of the country (Bufon 1971, 52). Four years later, G. Gruber's work for the Society was more technical and practical.

The sad story about the Gruber-Hacquet quarrels partly resulted from their mutually different karst theories. Both were able naturalists, not very tall but more than proud about their own respective achievements. They were certainly very friendly at the first place up to the fatal autumn of 1775,

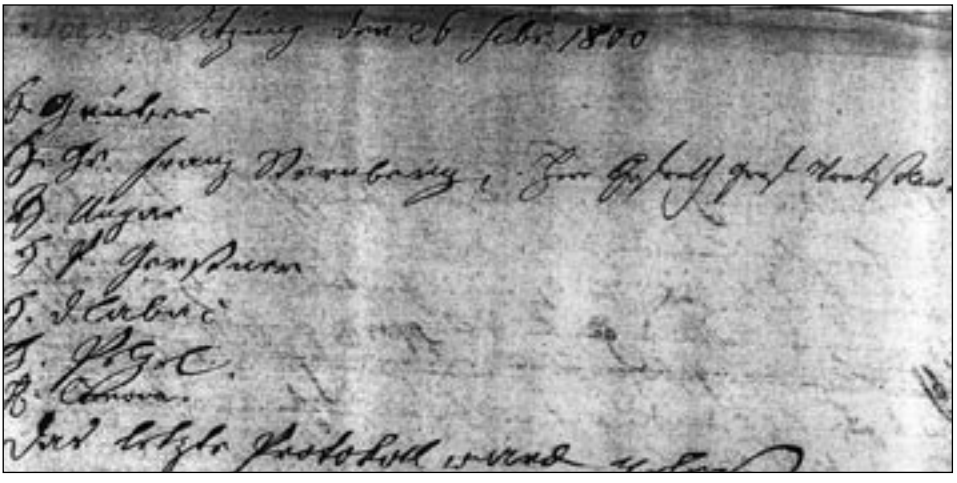

Figure 2: The signature of the president Tobias Gruber on the top of the document about the examination of Georg Vega's articles at Bohemian Scientific Society on February 26, 1800 (Archive of Bohemian Academy of Science. Prague. Leaf 13/1).

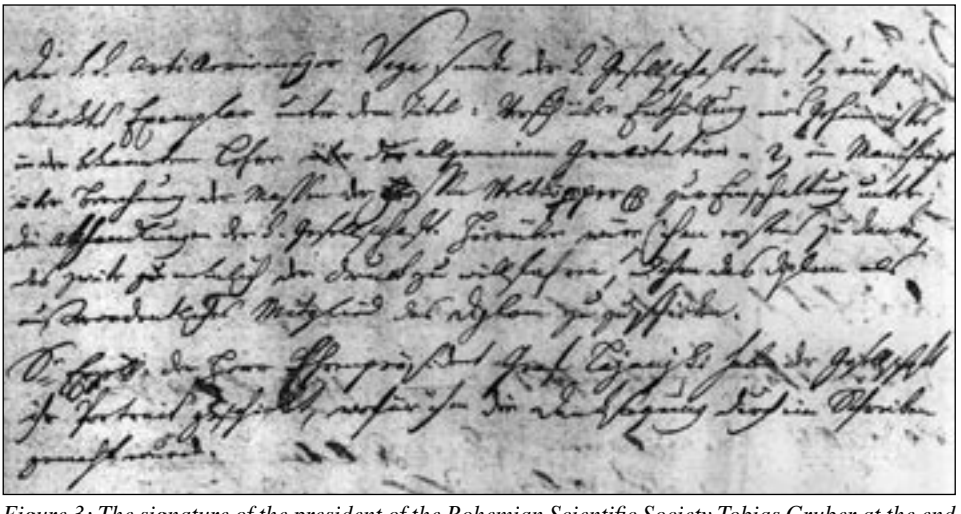

Figure 3: The signature of the president of the Bohemian Scientific Society Tobias Gruber at the end of the document about the examination of Georg Vega's articles at on February 26, 1800 (Archive of Bohemian Academy of Science. Prague. Leaf 13/2).

and they kept publishing at the same magazines even later. We proved that Gruber was backed by the new aristocracy wanting to get profit of his many useful ideas. Although a lonely researcher from the very beginning, Hacquet stood on the same shore with the old Carniolan aristocracy who saw Gruber aspiration for economic development as a treat to their old inherited privileges. On the other hand, Hacquet never liked the clergy and for his angry judgement Gruber seems to be just another one of those in black suits.

GRUBER'S SOURCES

Most of Gruber's published works dealt with Carniolan waters and their subterranean subsidiary streams. In Carniolan physical letters and later related works he cited many predecessors, although his citations were not always very precise. But we must understand his apparent imperfections: it was a different time with the different habits of quoting.

Year: page of citation	Cited author	Gruber's citation	Place, year of publication (Gruber did not publish the data in parenthesis)
1781: 114, 135, 156, 158; 1785: 21	Neron, Traian, Domician, Vergil, Horace		Antique
1784: 24	Plato	Timeaus about Athlantidis	
1781: 127, 130	Heron's burner		
1781: 6, 120	Von Garzarolli's mill, Blagaj's house	Ljubljana, surroundings	
1787: 11	Galileo Galilei (* 1564; † 1642)		
1781: 36, 110	Athanasius Kircher (* 1602; SJ; † 1680)	Mundo Subteraneo	Rome 1657
1781: 16, 36, 63, 102, 106, 110, 128	Janez Vajkard Valvasor (* 1641; † 1693)	Die Ehre	Ljubljana 1687
1781: 56, 88; 1787: 4, 10, 13, 15	Isaac Newton (* 1642; † 1727)	Principia, Optics	London 1687,1704
1781: 5	Durchlasser, Renner	Copper plate of canal	Ljubljana 1739
1785: 14, 15	Lehmann (Johann)	Von Flözgebirgen	(Berlin 1756)
1781: 16-17, 40-41, 110, 125, 141	Franc Anton von Steinberg (* 1684; † 1765)	Zerkitzen See	Ljubljana 1758
1781: 107, 138	Ivan Dizma Florjančič de Grienfeld (* 1691; † after 1757)	Map of Carniola	Ljubljana 1744
1784: 17	William Whiston's (* 1667; † 1752)	Comet	London 1698
1784: 7; 1785: 16	Christoph Traügott Delius (Del-lus), court advisor and professor in Schemnitz	Anleitung zu der Bergbaukunst	(Vienna 1773)
1781: 16	Giovanni Antonio Lecchi (* 17/11/ 1702 Milan; SJ; † 24/8/1776)		Milan
1781: 16	State (cameral) engineer Siegmund Hubert (Huebert, Huber, de Hübert)		
1785: 32	Gottfried Wilhelm Leibniz (* 1646; † 1716)	Protogaea	1749

1781: 136; 1785: 13, 20	Count Georges Louis Leclerc de Buffon (* 1707; † 1788)	Histoire de la Academie, mountain Nanos	(Histoire Naturelle)
1787: 14	Boškovi	Theoria	Venice 1763
1781: 131	Scherffer	Experiments at Vienna university	(Probably 1766)
1781: 17, 145	Maximilian Fremaut	Holland painting, Banat	
1787: 25	Joseph Xavier Liesganig (* 12/2/1719 Graz; SJ; † 4/3/1799 Lvov)	Dimensio Graduum Meridiani	Vienna 1770
1781: 156-158	Count Thurn, Pietro Imperati († 1605), Ulysse Aldrovandi (Ullisse, * 1522; †1605)		Venice 1602
1781: 156-158	Giovanni Fortunato Bianchini (* 27/12/1719 near Naples; † 2/9/1779 Padua)		Venice 1752
1781: 92; 1784: 3, 9	Janez Anton Scopoli (* 1723; † 1788)	Mineralogia; Fossilien	1769, 1772
1787: 6	Joseph baron Herbert (* 2/3/9/1725 Klagenfurt; SJ; † 28/3/1794 Vienna)	Gruber's letter	(1776)
1781: 75, 1785: 25	Joseph Walcher (* 6/1/1718 Linz; SJ; † 29/11/1803 Gutta)	Nachriten von den Eisbergen	Vienna 1773
1784: 12, 1785: 9, 10, 14	Giovanni Arduino (Arduini, * 16/10/1714 Caprino near Verona; † 21/3/1795 Venice)	Saggio fisico-mineralogico	Venice 1775
1784: 7, 1785: 3, 4, 23	Gottlieb Sigmund Gruner (* 20/7/1717 Bern; † 10/4/1778 Bern)	Beitrage zur Naturgeschichte des Schweizerlandes.	Bern 1775
1781: 113	Gruner	Naturhistoire des Schweizerlandes	Zürich
1785: 9, 10	Johann Jacob Ferber (* 1743; † 1790)	Briefe	(1774)
1785: 3	Jean-André De Luc (* 8/2/1727 Genf; † 7/11/1817 Windsor)	Glaciers in Savoy	(1778)
1784: 2	Delamétherie or Buffon	Beytrages zur Theorie der Erde	
1785: 22	Gruber's friend engineer Fischer	Mentioned at a footnote	
1785: 22	Johann Ehrenreich von Fichtel (* 29/9/1732 Bratislava; † 4/2/1795 Hemannstadt (Sibiu)	Navigational director on Tisa	
1784: 24	James Cook (* 1728; † 1779), captain	South seas research	(1774, 1777, 1784)
1787: 4, 6, 9, 29, 34-35	Johann Georg Büsch (* 3/1/1728 Alten-Meding in Lüneburg; † 5/8/1800 Hamburg)	Tractatus duo argumenti optici	Hamburg 1783
1787: 29	Inspector Deichgräber		
1781: 31	Vincenc Jurij Struppi (Strupi, * 1733; † 1810)		
1787: 34	Beurtheilung Physikalische Freunde	(Born's Physikalische Arbeiten der einträchtigen Freunde)	
1784: 2; 1785: 21; 1787: 3	Gruber		Vienna 1781

Table 2: Gruber's citations in Carniolan letters and related works.

Gruner was councilor in Waldschut near Bern (Poggendorff, 1863, 1: 965). Gruber citation of his work was incomplete because he omitted Gruner's collaborators De Luc and Jacob Samuel

Wyttenbach (1748-1830).

Because Gruber clearly claimed to Fischer to be his personal friend, he was most probably Jožef Karel Fischer, the chief consignee of the Carniolan customs office. Other less probable candidates were Ernst Gottfried Fischer (* 17/7/1754 Hoheneiche; † 27/1/1831 Berlin), and Johann Carl Fischer (* 5/12/1760 Altstädt; † 22/5/1833 Greifswalde), professor of Jena university.

Gruber also mentioned Fichtel who was appointed gubernial councilor at Siebenburgen (Transylvania) in 1787. Both Grubers knew the area and certainly also Fichtel very well. Gabriel was sailing on the river Marica (Maroch, Maros, Mures) and planing navigational works there between autumn 1772 and spring 1773 as the navigation director. Later between 1774 and 1777, Tobias became the director of Transylvania navigation on his half brother's recommendation.

Although Gruber cited a lot, he failed to mention some books about the subterranean waters available at Ljubljana Jesuit library. Among them we found very popular Johann Gottfried Jugel's (1707-1786) miner's encyclopedia. Jugel published his work in the year of the suppression of the Jesuit order and it was immediately bought for the Ljubljanese higher studies. Jesuits owned the book but did not sign their usual bookplate on the title, because the work was probably bought just in the troublesome year 1773 of the suppression of Jesuit order.

Gruber mentioned many non-Jesuit authors. He also showed some impatience for the people of different opinions from his own, but mostly just for fun. Therefore he mentioned Fremaut as a man

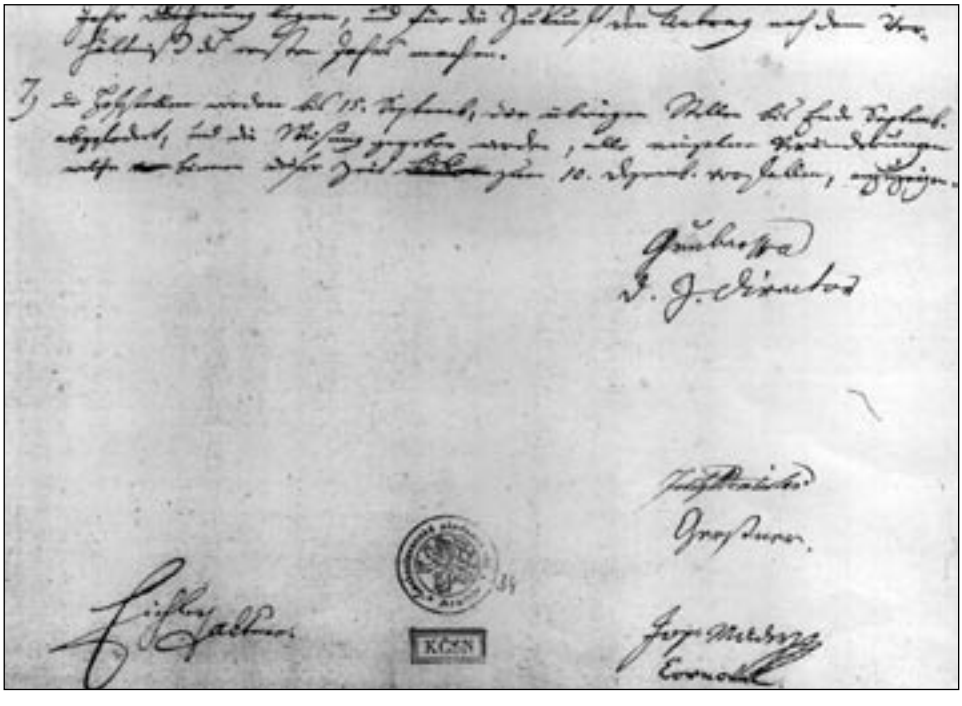

Figure 4: The signature of the president and director Tobias Gruber under the examination of Georg Vega's articles at Bohemian Scientific Society on April 19, 1800 (Archive of Bohemian Academy of Science. Prague. Leaf 27).

of »unspiritual name« (Gruber, 1781, 17), whom he didn't know personally. The joke was referring to freemasons who were probably not always on Gruber's political line. Gruber called Vincent Strupi the Femaut's "great successor", who finally finished Gruber's canal according to the wishes of Carniolan Estates general (Gruber, 1781, 31). Gruber closely collaborated with the freemason naturalist and former Jesuit Born, the master of Vienna lodge. That was not very extraordinary because Bošković himself made friends with the freemason American diplomat Benjamin Franklin (1706-1790).

CERKNICA LAKE

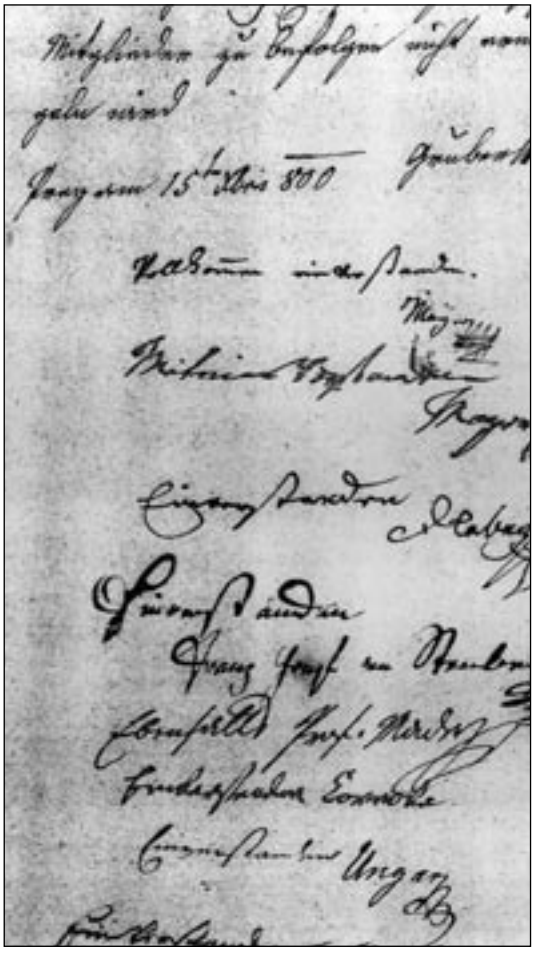

Figure 5: The signature of the director Tobias Gruber beneath the examination of Georg Vega's articles at Bohemian Scientific Society on December 15, 1800 (Archive of Bohemian Academy of Science. Prague. Leaf 53/2).

Kircher published one of the first researches of the Carniolan waters and Cerknica Lake. He never visited our lands personally although he was very close once in his career. He was offered a chair at the college of Trieste in 1633, but he went to the Roman college instead.

Englishman Edward Brown (1642-1708) researched Cerknica Lake in 1669. His description was curious enough to prepare later Valvasor's success at Royal Society. Janez Ludvik Schönleben (1618-1681) accepted Kircher's explanation of the rising and falling of the water in Cerknica Lake. Schönleben was archdeacon of Ribnica. Between 1667 and April 24, 1676, he also administrated the parish of Cerknica. As Gruber after him, he accepted the Plutonist theory about the plunging of the surface into the cave. Later, the hollow was filled up with the water. Schönleben was also aware of the subterranean rivers, among them Timavo and Pivka (Habe, Kranjc 1981, 17).

Gruber published 29 vignettes in front of his 1781 letters. As a famous artist G. Gruber painted the pictures, and the engraver Jacob Adam from Vienna signed some of them. The characters at vignettes indicated the more important points and flows mentioned in the text. The first three vignettes dealt with the waters of Ljubljana. The next twenty-six vignettes showed the caves and waters at Karst in

Carniola, especially in connection with the lake of Cerknica. The vignette showing the cross section of the nearby mountains described the subterranean flows into the lake (Gruber 1781, 131).

Baron Janez Vajkard Valvasor (1641-1693) and Franc Anton von Steinberg (1684-1765) personally researched the waters of Carniola. On November 17, 1687, Valvasor published drawings similar to later Gruber's. He annotated the underground beneath the lake Cerknica with the characters of alphabet. For that work Valvasor was elected a fellow of the Royal Society in 1687 (Reisp 1987, 8, 9, 85). A century later, Gruber made a short presentation of Valvasor and Steinberg's work (Gruber 1781, 16).

Steinberg's researched Cerknica Lake between 1718 and 1720. Four decades later he examined the region again and discovered that the bushes and trees covered some caves in-between (Gruber 1781, 119, 141; Habe, Kranjc 1981, 20; Smole 1982, 111, 313).

During the same trip, Gruber visited Cerknica and the famous Idrija mine. He measured the differences in height with his own barometer (Gruber 1781, 35, 37, 101, 124, 154). He accurately described the circulation of the air caused by the temperature variations, the lowering of pressure after the thunder, and the thickening of air in the caves (Gruber 1781, 123-124).

He followed the contemporary expert literature and compared the circumstances around the lake of Cerknica with the published research of Tyrol (Gruber 1781, 75). He refused Valvasor and Steinberg's model of the infinite row of siphons under the hill of Javornik, which was supposed to pour over the rain-water into the lake. Gruber's rains at the Cerknica field regulated the water of the lake in spite of the different Valvasor and Steinberg's ideas. The oscillation of the lake water level followed the rainfall circumstances with the period of 2-3 or 7 years and did not follow the yearly seasons.

Gruber stated that the experience in nature and the debates with native people make more use than the best theories (Gruber 1781, 110-114, 116). He compared the subterranean effects beneath Cerknica Lake with the connected vessels. He used the analogy with the Harvey's flow of blood. The Englishman William Harvey (1578-1657) studied at Padua and he knew about the nearby Caniolan karst phenomena.

Gruber illustrated his connected vessel models with the first three pictures of his third plate. The first two pictures contained the parts of the connected vessel presented as a whole on the third picture. The inflow of the vessel was regulated by a valve. The water could flow to the lower, but also to the higher container.

In next to last letter numbered 11 and mailed on June 22, 1779, Gruber compared Cerknica lake with the hydraulic machine and with the model of Heron's reactive burner. He estimated the height of the fountain by the pressure in the underground water canals. Gruber described the subterranean flows by the principle of siphon (Gruber 1781, 127, 130) and Daniel Bernoulli's hydrodynamics. According to the manner of his time Gruber didn't publish equations to shorten his text.

THE SUBTERRANEAN RIVER TIMAVO

On November 6, 1779, Gruber dated his last 12th letter, nearly five months after the previous one. Gruber interrupted his correspondence with Born during his travel from Postojna to Gorizia and rested for a while on the seaside near Trieste. He also visited the Alps of Friuli. Afterwards he returned to Ljubljana and mailed his very last letter published in 1781 (Gruber 1781, 133-134).

In his last letter Gruber presented his classical education. He cited Roman poets and wrote that already Roman emperors had their summer residences in those areas between Duino and Udine, which became fairly known after the campaign of Huns (Gruber 1781, 135, 145, 156).

Gruber was a sophisticated traveler. He didn't forget to mention the robbers to be aware of in the area of Dolomites between Vrhnika and Postojna. He compared the littoral rivers with those he had seen earlier in Banat (Gruber 1781, 136, 145, 150). The mention of Banat indicated Tobias' collaboration in that research. He finished his navigational directorship in Banat two years before Born received the letters. Gabriel worked in Banat already before Tobias' arrival, and Tobias probably later visited Gabriel in Carniola (Habe, Kranjc 1981, 21). The letters were certainly the result of their joint work.

In his description of the subterranean flow of the river Timavo Gruber cited a letter of the Benedictine Imperati from the cloister of Santo Spirito in Duino near the sources of Timavo. Count Rajmund Thurn-Valsassina (Turizmund, Raimondo della Torre) built the cloister in 1598, shortly before Imperati's letter. Thurns owned the castles of Sistiana (Sesljan) and Duino (Devin, Tybein) near the river of Timavo between 1459 and 1865 (Smole 1982, 132, 438).

In September 1602, Imperati from the Pucino castle mailed the answer to Bologna naturalist Aldrovandi. Aldrovandi owned a famous library with 360 handwritings and 3800 printed works. In 1605, he published a book about fishes. In that same year, he and Imperati died in Bologna (Tavagnutti 2000; Zorzi 1995, 184).

Aldrovandi described Imperati's weighted pieces of wood and other objects used to check and prove the connection between Reka and Timavo. The experimenting of that sort doesn't sound very modern, but those were a very different times. It was claimed to be the very first described test of a subterranean flow (Forti 1990, 210). In 1752, Bianchini found a part of Imperati's letter at the cloister of Santo Spirito (Gruber 1781, 157; Bianchini 1754, 85-86). Two years later, Bianchini decided to publish Imperati's letter and he added two pages of introduction and comment.

In the same paper Bianchini published two other letters of his own before he dealt with Impetati's work. The first letter explained the thunder electricity. Gruber certainly knew a legendary Benjamin Franklin's kite experiment, because in 1775 the Hungarian Jesuit Paul Mako von Kerek-Gede's (1721-1793) work about thunder was published in Ljubljana.

In his second letter of 1754, Bianchini described the source and the Timavo subterranean flow in the Gorizia area. In Antiquity, the name Timavo was also used for the river later called Reka (Recca). Timavo was rightly claimed to flow to the sea underground (Bianchini 1754, 74; Forti, 1990). Valvasor was clearly wrong when he described the subterranean connection between Timavo and the lake Dobradò (Bianchini 1754, 71). Before him, Imperati rightly supposed an underground connection of Timavo and the river Reka. He stated that Reka sank twice into the caves in-between, before it finally sprang as Timavo (Gruber 1781, 157; Bianchini 1754, 78). Bianchini systematically researched the caves at the karst around Trieste to find the connection of the subterranean river and the lake of Cerknica. The water of Timavo was drinkable although the underground admix of the soil and sea finally combined an unusual taste (Gruber 1781, 157-158; Tavagnitti, 2000, 2).

Bianchini mailed his second letter to the count Gvido Kobencl (Gvidon, Guido, Guidobaldo Cobenzl, 1716-1797) from Gorizia. Gvido was a younger brother of Bošković's friend count Janez Karl Filip Kobencl (1712-1770), Maria Theresa's diplomat born in Ljubljana. One of Janez Karl Filip's officers in Brussels was Gvido's son Janez Filip Kobencl (1741-1810), later court advisor of the Emperor Josef II. In 1757, Janez Filip recited a poem to honor Bošković's presence during his

final examinations at Theresianum in Vienna.

Bošković also collaborated with Bianchini. On June 3, 1754, Bošković summed up a decade of his research of waters at the port of Rimini in a letter mailed to Bianchini. Bošković added the letter to his 75 pages of astronomical treatise which he already published in the previous year (Marković 1969, 665). As the future leading politician, G. Gruber was probably aware of his teacher Bošković connections with Bianchini and Kobencls.

Already in 1597, the Kobencl family owned a palace in Gorizia where Gvido Kobencl was born. His mother was Carlotta von Rindismaul. His father Janez Gašpar (1664/1669-1742) was the general governor of Gorizia, and after 1714 of Carniola. After his death, Gvido inherited the manor of Ribnica which he later united with the neighboring manor of Breg. In 1747 he moved from Ljubljana to Gorizia. His two sisters were married to the Gorizian counts Coronini and Edling. Gvido frequently visited the manor Lože near Vipava (Leitenburg near Wippach). In 1764, he inherited it after the death of his uncle count Ludvik Gundakar Kobencl.

Gvido Kobencl and Coletti helped to establish the learned society »Accademia degli Arcadi Romano-Sonziaca« in Gorizia. Gvido served as its first president. Later in 1789, the society formally became a branch of the Arcadians of Rome. Therefore Bianchini in his letter had every right to praise Kobencl's »knowledge of physics and mathematics« (Bianchini 1754, 81).

Bianchini mostly wrote to Kobencl about geography. Besides the caves around the river of Timavo he also described Nile and other famous rivers. He claimed at first that the river under the Janez Karl Filip Kobencl's castle of Predjama (Jama, Luegg) near Postojna was also connected with the subterranean flow of Timavo. Later Bianchini researched numerous caves in Littoral and finally discovered that just Reka was flowing out to Timavo under the earth. The supposition proved to be a right one and Gruber accepted it (Tavagnutti 2000; Gruber 1781, 157).

The last 29th Gruber's vignette showed the flow of the river Timavo beneath the castle of Duino. Gruber finished his letters with the description of fifteen greater subterranean rivers in Carniola (Gruber 1781, 160 (unpaged)).

Even few months before his election for a Jesuit General, Gruber used his hydrographic knowledge to propose the digging of the Save riverbed for better sailing. The reviewer of the article wished »a favorable reception« for Gruber's proposition (Gruber 1802, 217). But Gruber's plan was never put into action, among others because o severe Hacquet's criticism of the Save sailboats transportation.

ELECTRICITY

Gruber refused the electrical charge of the subterranean waters as one of the uncritical early use of Franklin's theory. Steinberg and Bošković partially followed Franklin's line of reasoning. Gruber witnessed several thunder strokes, among them into the Vranja cave waters. The electrical spark could spread through the air closed between the walls of a cave. The pressure of electrified air and the sulphur vapors could squeeze the water through the holes in hills. The electrical properties of air changed with its density (Gruber 1781, 121-122; Gruber 1787, 32), but for Gruber that was not sufficient proof for the electrification of the subterranean air.

THE STALACTITES

Gruber used Newton's mathematical research of the hyperbolic cosine or chain. The force of their own weight arranged the freely hanged parts into a chain. The limestone deposited from the water along a chain and slowly elongated the stalactites in the karst caves (Gruber 1781, 87-88). Gruber's »ground sentence of crystallography« described the limestone separation. Each eliminated drop constructed a new part of the chain. The crystallized matter composed new wider stalactite films. The shape of the stalactite reminded Gruber of the pipe-organ tubes (Gruber 1781, 90). He illustrated the stalactite formation model with a diagram on the last plate at the end of his book.

Gruber was the very first to use Newton higher mathematics for karst phenomena description. He was predestinated for such achievement because of his superb mathematical training combined with the broad interest in Carniolan karst. The stalactite formation seemed to be the ideal frame for such a pioneering work which certainly surpassed the research of his fellow naturalists including Hacquet who were usually not familiar with mathematics.

GRUBER'S THEORY OF THE EARTH

Gruber researched the mountains of Carniola to solve the problems of theory of the Earth. He used Bošković's description of the surface of the Earth which later developed into the modern Geoid theory.

Three and four years later, Gruber published the continuation of his 1781 letters in Born's magazine. This time he didn't publish the places an dates of letters or vignettes. In both continuations Gruber discussed fundamental theory and did not just describe the peculiarities of Carniola geology and his own work on the canal.

Other papers published in Born's review dealt with the new science of the day called mineralogy, and also with geology, horography, botany, and zoology. Most of the authors discussed the circumstances in Habsburg monarchy, some of them also in Siberia and both Americas. Born published the abstract of the works of famous authors, among them Linné's student Swede Tobern Olof Bergmann (Bergman, 1735-1784) from the university of Uppsala. In three volumes printed between 1783 and 1785, Born published just one paper about physics. The author, a professor of the higher mathematics Franz von Kesaer, investigated the central forces.

In 1784, Gruber started his paper with the citation of his own letters. He wrongly cited three years older year of their issue instead of 1781. Without notion of the author he mentioned the work "Beytrages zur Theorie der Erde". The title was similar to the later translation of the book of chemist Jean-Claude Delamétherie (1743-1817), the editor of Journal de Physique in Paris (Gruber 1784, 2). In 9th letter on June 1, 1779, Gruber mentioned his older work: »…a month later I published a great work, whose small part are those letters …« (Gruber 1781, 104). We have no other data about his work of 1778 or 1779.

Gruber cited Janez Anton Scopoli's (1723-1788) books on mineralogy, fossils and flora of Carniola (Gruber 1784, 4, 9). During the school year 1768/69, south Tyrolan Scopoli and G. Gruber worked in the nearby towns of Idrija and Ljubljana in Carniola. It is very probably that they met each other. They had some common research interest and also shared their antagonism towards Hacquet. Gruber compared the situation in Karst with Dellus and Gruner's research of the Switzerland Alps (Gruber 1784, 7).

Gruber used the especial forces to explain the process of drying up and other process of hardening (Gruber 1784, 15). He believed in two big prehistoric deluges which didn't reach the highest mountains. Gruber's earthquakes were unable to carry the matter from the one position to another and that was one of Gruber's Neptunist arguments (Gruber 1784, 17).

Gruber believed that the extra pressure was due to the release of the air into the underground caves and explained the forces at the foot of the hill with the buoyancy and pressure of the compressed air in caves (Gruber 1784, 19, 20, 22). The subterranean and under sea pressure of water and/or air caused the recent earthquakes of Lima and Lisbon (1755) as John Michell (1724-1793) claimed already in 1760 (Gruber 1784, 24). Subterranean waters deluged a part of the surface of Earth, and the subterranean air caused smoke, fire, and ashes.

Gruber's theory of Earth was based on Kircher's description of the subterranean heat, lakes, and empty space in caves. Gruber claimed that the subterranean weather is just as changeable, as in the atmosphere. Gruber considered the sea trumpets and water towers as a kind of subterranean electric discharge from the bottom of the sea into the atmosphere. The same discharge was supposed to cause the lightening in the clouds (Gruber 1784, 13, 19, 24). As late as 18th century, the Jesuits frequently used the ideas about the influence of the subterranean conditions on weather.

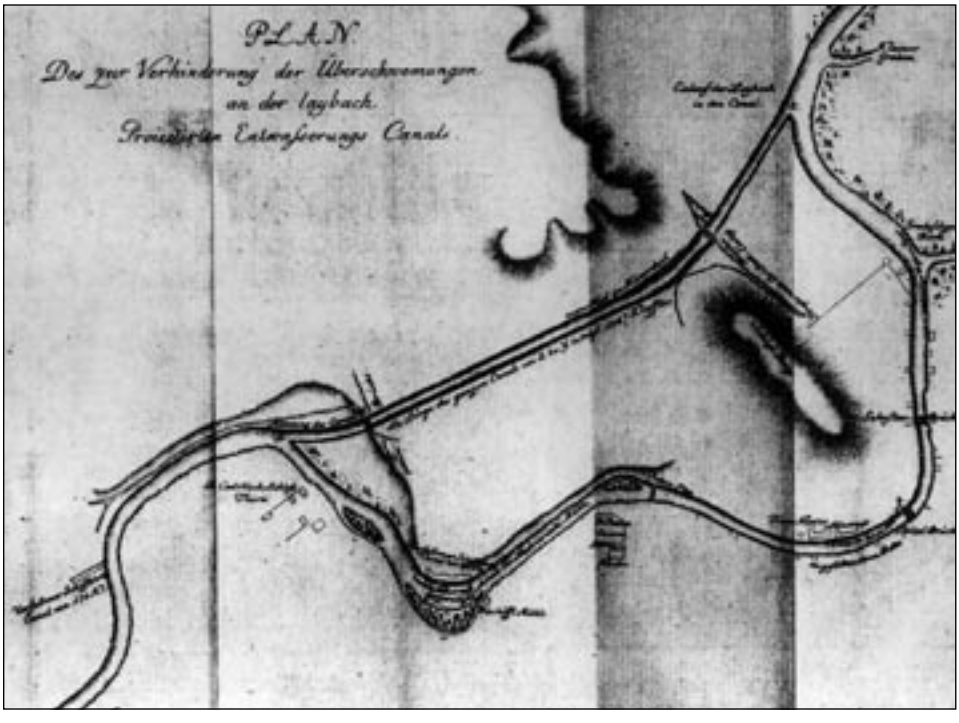

Figure 6: Gruber's canal in Ljubljana (Gruber, Tobija. 1781. Herrn Tobias Grubers, Weltpriesters und k.k. Bau- und Navigationsdirektors im Temeswarer Banat, Briefe hydrographischen und physikalischen Inhalts aus Krain an Ignaz Edlen von Born k.k. wirklichen Hofrath. Vienna: Johann Paul Krauss.).

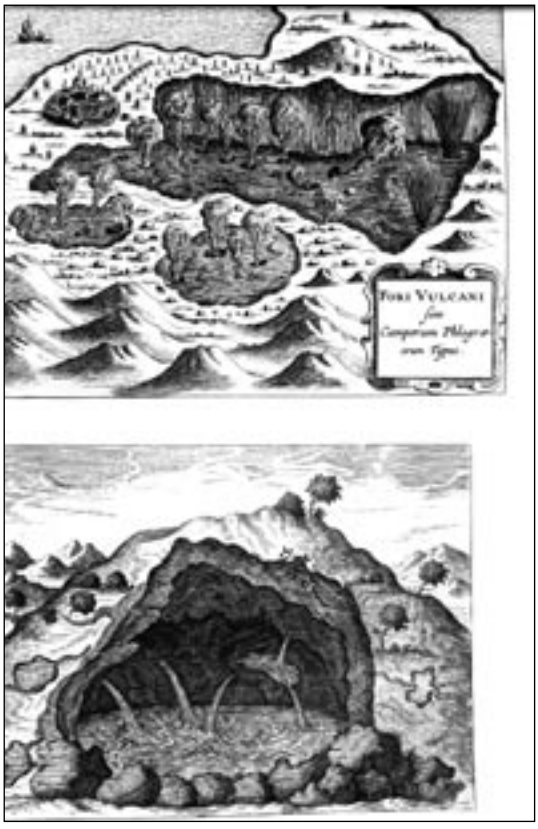

Figure 7: Kircher's model of the subterranean as the system of arteries (Kircher, A., 1657: Athanasii Kircheri e Soc. Jesu Iter extaticum II. Qui et Mundi Subterranei Prodromus dicitur. Quo Geocosmi opisicium sive Terrestris Globi Structura, unà cum abditis in ea constitutis arcanioris Naturae Reconditoriis, per ficti raptus integumentum exponitur ad veritatem. In III. Dialogos distinctum. Ad Serenissimum Leopoldum Ignatium Hungariae, et Bohemiae Regem. Typis Mascardi, Rome. M.DC.LVII. Third edition, 1678: Amsterdam.)

Figure 8: Kircher's model of volcano and lake San Gotard in Alps (Kircher 1657).

Gruber explained the trembling during the earthquakes by the mutual pressure, or the pressure of compressed air. The pressure of water can cause the first earthquake stroke without the high tides. The electrical or volcanic setting of fire in the empty space of caves caused the second stroke that raised the velocity of the air in the middle of the denser bodies. The compressed or decompressed air caused the third stoke that broke out into the equilibrium of atmosphere and vibrated the mass of the earth between the caves and atmosphere. The high tides and storms went along with the earthquakes. The similar events could happen when the empty space was filled with the water or sank very deep in the water (Gruber 1785, 1-2). Gruber was clearly aware of the connection of earthquakes and terrestrial magnetism (Gruber 1790, 179) although the phenomena are not clearly explained even in modern science.

Gruber's fossil remains of the animals that supposedly lived in the depth of the former seas could be compared with Gruner and Jean-André De Luc's (1727-1817) research in Switzerland and Savoy. In 1775, Gruner was convinced that later movements of the surface brought fossils to the higher levels above the sea (Gruber 1785, 4). Gruber didn't cite De Luc's works, but in spite of that omission he probably read some of them in French language, let's say De Luc's letters about the fossils in Savoy published in 1778 (Ellenberger, Gohau 1981, 217, 220, 222-223, 225, 234, 250; Chang 2001, 254).

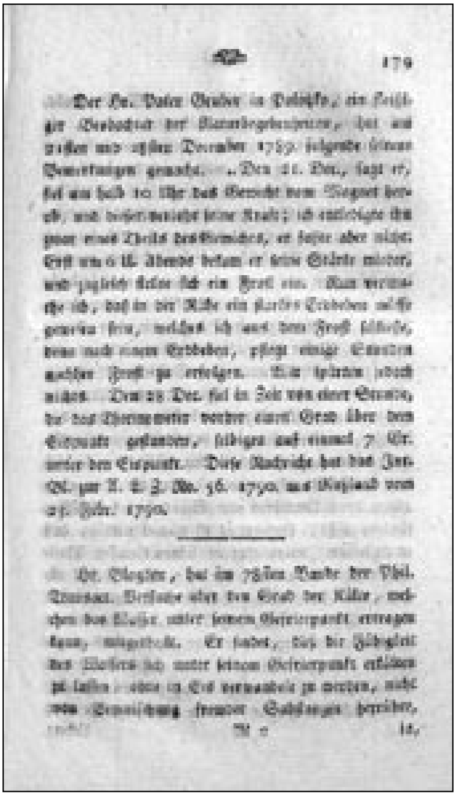

Figure 9: Gruber's report about the connection between the terrestial magnetism and earthquakes (Gruber, G., 1790: Gruber in Polosko. Magazin für das Neueste aus der Physik und Naturgeschichte. 13te Büch, 7ten Bandes, 1tes Stück: 179).

Gruber used Gruner's description of the glaciers related natural catastrophes and accepted the modern theory of former seas in the upper regions. The changing of equilibrium between the earth, air, and water caused the changes (Gruber 1785, 7). Gruber explained the catastrophic removal of some denser granite parts above the rarer ones, although the crystallization of the water deposits should led to the opposite result and backed his ideas with Arduino and Ferber. Ferber translated Arduino's works, corresponded with Born, and visited Scopoli as Linné's messager.

Gruber wrongly supposed that all higher places in our planet were built-up of the limestone, also the tops of mountains (Gruber 1785, 29-30, 89). He seems to be unaware of the darker volcanic mountains of Ands in South America, although he should have been informed about them from his fellow Jesuits from the missions.

In his chemistry of the Earth's surface Gruber described the »smallest parts« of salt, oil, soil, and metals in water (Gruber 1785, 10). In 1775,

Arduino published the research about solutions with plants and animals in a work that included Hacquet paper about iron ore (Ellemberger, Gohau 1981, 237, 244-245; SBL, 1925-1932, 1: 285).

Contrary to Delius, Gruber saw in the water collected above the stratum of clay the conditions similar to the flood. (Gruber 1785, 16-18). Therefore Gruber didn't completely reject the alchemy and that was one of grudges Hacquet bore against him.

The earthquakes above the clay stratum are much more dangerous than in the karst regions as Buffon stated before Gruber. Previously Gruber spelled his name in German form »von Büffon« (Gruber 1785, 19-20; Gruber 1781, 136) because he probably didn't use Buffon's French original. In 1789, Hacquet as the founder of the science of karst also investigated the clay (Barić 1978, 116; Habe, Kranjc 1981, 24).

Gruber described the remains of shells in the former bottom of Pannonian Sea left after the worldwide lowering of the sea level in Slankamen and on the hills of Banat (Gruber 1785, 22). As the sea flowed off through Danube, the former bottom was covered by the stratum of the black soil, »the mother of all plants«. Gruber compared ancient Pannonian flowing off with the periodic flowing from the lakes of Cerknica and Tyrol in 12 years older Walcher's description. Guber wrongly believed that underground water vapors penetrated into the atmosphere and influenced the weather. In the same way influx of vapors ruined pointed tops of the mountains. The underground limestone acted as the huge reservoir of water (Gruber 1785, 25, 30, 31). Many sinking of the great islands supported the existence of the underground limestone areas of irregular shapes. The underground heat and vapors diffused along the several miles of slots in oceans and acted as a distil pots (Gruber 1785, 32; Ellenberger, Gohau 1981, 240).

Gruber immersed his mountains in the sea water of the underground caves. He borrowed the idea from Leibniz' hundred years older model of the Earth's surface described as the glass-like coverage. Leibniz accepted the transformation theory with catastrophes. In 1683, Leibniz described fluid interior of the Earth as the fundament of later Charles Lyell's (1797-1875) geology.

Gruber's ancient European seas and their sediments approached Neptunists with some components of the metamorphose geology. Gruber's idea of the two deluges in the history of the Earth was similar to the catastrophist of De Luc and later Cuvier's description of the revolutions on the surface of Earth published in 1812. On the other side, Gruber preferred Plutonist formation of the lakes after the downfall of roof to the bottom of caves. He used landslides to explain the natural bridges and arcs (Gruber 1781, 108; Gruber 1784, 4; Habe, Kranjc 1981, 21).

CONCLUSION

The opposite geological ideas broadened the personal antagonism between G. Gruber and Hacquet and prevented their joint research. In other circumstances their collaboration could be a real benefit for Carniola, always divided between two incommensurable political parties of whatever color.

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GRUBERJEVO RAZISKOVANJE KRASA

Povzetek

Ob dvestoletnici smrti Gabrijela Gruberja smo opisali njegovo raziskovanje krasa, Cerkniškega jezera in reke Timav. Gruberje, Dunajčane slovenskega rodu, smo opisali kot eno najbolj uspešnih družin raziskovalcev krasa in drugih naravoslovnih ved pri nas. Gabrijelove ideje je njegov mlajši polbrat Tobija objavil pod svojim imenom. Sestavili smo podroben opis profesorskih mest in drugih položajev, ki jih je Gabrijel opravljal pri nas in v Rusiji. Prvič v zgodovinopisju popisujemo citirana dela v Gruberjevih objavah o krasu. Ugotavljamo izredno učenost našega junaka, ki mu je omogočala pregled nad vsemi tedanjimi dognanji. Pregledali smo Gruberjev opis kapnikov ter Cerkniškega jezera po analogiji s hidravličnimi stroji in Heronovim reakcijskim gorilnikom. Gruber je prav tu dokazal svoje prednosti pred drugimi raziskovalci krasa, saj jih je prekašal po svojem matematičnem znanju, še posebej glede Newtonove višje matematike. Tako je prav Gruber med prvimi uporabil višjo matematiko za študij kraških pojavov in še posebej kapnikov. Podrobno smo obravnavali Gruberjevo zadnje pismo o reki Timav. Povezave Timava s krasom so bile temeljnega pomena pri Gruberjevih načrtih za vodno povezavo med Jadranom in Savo, ki bi omogočila argonavtsko plovbo vse do Črnega morja. Spor med Gruberjem in Hacquetom po letu 1775 smo skušali osvetliti tudi z nasprotji pri njunem pojmovanju krasa. Izrazili smo svoje obžalovanje, da ni prišlo do širšega sodelovanja med obema velikanoma našega tedanjega naravoslovja.