NOTES

Alpine Salt Mining in the Middle Ages

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Sometime in the XIIth Century at an altitude of about 1200 to 1700 m above sea level, salty springwater appeared in various areas of the eastern arc of the northern limestone Alps. Boiling away this water in small pans provided salt for local needs, but such springs were not particularly productive. [1]

Probably still in the XIIth century the Archbishop of Salzburg had workers dig for salt underground at Mt. Dürrnberg near Mühlbach, which later got the name Hallein, since the salt springs near Mühlbach had apparently dried up. [2]

At about the same time the Augustinian canons provostry in Berchtesgaden may have begun to mine for salt on Mt. Tuval. Later numerous disputes arose between the Archbishop of Salzburg and the provostry in Berchtesgaden about the salt mines on Mt. Tuval and Mt. Dürrnberg. In the course of these disputes, which were underscored on both sides by a then extremely well-proven method — namely forgery of documents — there were continual references to "veni sub-terranei salis" on both mountains. [3] This certainly clearly indicates that salt mining was known at the beginning of the XIIIth century in both the Salzburg and Berchtesgaden regions.

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[1] Cf. August Aigner, *Der Salzbergbau in den österreichischen Alpen*, in: Berg-und Hüttenmännisches Jahrbuch 40 (18929, p. 203 ff.; Kurt Thomanek, *Salz in Österreich, in: Stadt und Salz*, ed. by Wilhelm Rausch (Beiträge sur Geschichte der Städte Mitteleuropas 10) Linz/Donau 1988, p. 171.

[2] Cf. Fritz Koller, *Hallein in frühen und hohen Mettelalter*, in: Mitteilungen der Gesellschaft für Salzburger Landeskunde 116 (1977), p. 1 ff.; Rudolf Palme, *Rechts-, Wirtschafts- und Sozialgeschichte der inneralpinen Salzwerke bis zu deren Monopolisierung* (Rechtshistorische Reihe 25) Frankfurt a. Main — Bern 1983, p. 37.

[3] Heinrich Appelet, *Die Urkunden Friedrichs I. 1252-58* (Monumenta Germaniae historica 10/1) Hannover 1975, pp. 234-236, nr. 140; Salzburger Urkundenbuch 2: Urkunden von 790-1199, ed. by Willibald Hauthaler and Franz Martin, Salzburg 1916, p. 724 nr. 531; cf. Koller, *Hallein*, p. 40 ff.; Palme, *Salzwerke*, p. 56 ff.

In the year 1147 Margrave Otakar III made a gift of two salt pans for saltmaking in the Enns Valley near Mt. Ahorn to the Styrian Cistercian monastery of Rein. [4] Only when these sources were almost dried up did the Brothers in Rein have a new saltery constructed on Mt. Ahorn in 1211, namely "in qua exuberantem salis uenam inuenerunt quam suis ut libuit et licuit, usibus aptauerunt". [5] Following their example, the Babenberg Duke Leopold VI had another tunnel dug close by on the same mountain and put experienced persons in charge of it. As a result, a dispute developed between the salt mines of the sovereign and those of the monastery; since the former was stronger, the entire mining facilities of the monastery were seized and the Cistercians lost their customary amount of salt. After repeated remonstrances on the part of the monastery the Babenberg sovereign ordered that as payment for its work and as a settlement for its salt mine the monastery of Rein was always to receive 100 bushels of salt yearly from the sovereign's "officiales" and the tenth Mark from the excess profit of the ducal mine, even if this excess profit were to reach 1000 Marks or even more. [7] In Aussee, therefore, the sovereign forcibly assumed possession of the saltery and the mine apparently from the moment the Cistercians of Rein opened up their salt mine.

In the year 1283 Adelheidis, the widow of Heinrich, Knight of Thaur, received in the presence of Count Meinhard II of Görz-Tirol, among other things, 60 cartloads of salt, the yearly supply of which Count Meinhard had bequeathed to her as a wedding gift and which came from the "fondina salis, que Halle dicitur". [8] "Fondina", however, can only be understood as mine or pit. [9]

[4] *Urkundenbuch des Herzogthums Steiermark 1: 798-1192*, ed. by Joseph von Zahn, Graz 1875, p. 271, nr. 261; cf. Heinrich von Srbik, *Studien zur Geschichte des österreichischen Salzwesens* (Forschungen zur inneren Geschichte Österreichs, ed. by Alfons Dopsch, 12) Innsbruck 1917, p. 19; Othmar Pickl, *Beiträge zur Wirtschaftsgeschichte der Zisterze Rein bis zum Beginn der Neuzeit*, in: Stift Rein 1129-1979. 850 Jahre Kultur and Glaube. Festschrift zum Jubiläum, Rein 1979, p. 127; Franz Stadler, *Salzerzeugung, Salinenorte und Salztransport in der Steiermark*, in: Stadt und Salz, ed, by Wilhelm Rausch (Beiträge zur Geschichte der Städte Mitteleuropas 10) Linz/Donau 1988, p. 107.

[5] *Urkundenbuch des Herzogthums Steiermark 2: 1192- 1246*, ed. by Joseph von Zahn, Graz 1879, p. 173. nr. 116.

[6] Cf. Stadler, *Salzerzeugung*, p. 110.

[7] *Urkundenbuch des Herzogtum Steiermark 4/3: 1270-1276*, ed. by Heinrich Appelt and Gerhard Pferschy, Wien 1967, p. 341, nr. 570.

[8] Hermann Wiesflecker — Johann Rainer (Ed.), *Die Regesten der Grafen von Tirol und Görz, Herzoge von Kärnten* 2/1: Die Regesten Meinhards II. (I.) 1271-95 (Publikationen des Instituts für Österreichische Geschichtsforschung, ed by Leo Santifaller, 4/1) Innsbruck 1952, p. 102, nr. 373.

[9] Cf. Otto Stolz, *Die Anfänge des Bergbaues und Bergrechtes in Tirol*, in: Zeitschrift für

A further source of information is the "Liber officii saline Hallis vallis Eni", whose original is still lost but whose contents have been handed down in two transcriptions from the XVth century which are kept in today the Tirolean State Archives. [10] It represents an early type of legal codification for salteries and salt mines and probably stems entirely from the second half of the XIVth century. Its oldest edition, however, may well reach back in part to the time of Heinrich, a son of Meinhard II. A passage reads as follows: "Man sol wissen, das der perg und das salzsyden ze Hall in dem Intal auffgevangen und erfungen ist vor hundertunddreyssnig jaren bey herzog Meinharzs seligen zeitten, und das ist geschechen von ainem frummen ritter, ist genant gewesen herr Nyclas von Rörnpach, der sollich chunst und genad von Got het, das er ein recht maister was zu allem pergerz, goldes und sylbers, als er mit seiner chunst in manigen landen hat erzeiget und volbracht, des er noch in allen landen lob und er hat". [11] In Codex 3176, about ten years older (from about 1462), a note in red ink follows which was left out in Codex 3177: "Anno domini M°CC°LXXXXV° obiit dux Meinhardus und also ist das salzsieden zu Hall im Intal pey seinen zeitten vor seim tod auf XV oder XX jar angevangen, etc". [12]

The obvious assumption is that this note in red ink was a marginal note in the original which was added later; the writer of Codex 3176 apparently was not certain about the date of writing of the original and calculated back only the approximately 15 to 20 years before Meinhard's death. [13]

Knight Nikolaus von Rohrbach, who therefore developed the mine at the order of Meinhard, came from the Styrian mine in Aussee, which had in the meantime become the property of the Habsburgs, to Hall in Tirol. [14] Count Meinhard II certainly had close relations with the Habsburgs as his daughter Elisabeth was married to King Albrecht I. Perhaps count Meinhard learned of the enormous increase in production in the Aussee mine and had the experienced Nikolaus von Rohrbach come to Tirol so that he could take over the development of the Hall mine as well. Just a short time before this Meinhard II had

Rechtsgeschichte, German. Abt., 48 (1928), p. 224; Palme, *Salzwerke*, p. 60; Rudolf Palme, *Rechtliche Probleme bei der mittelalterlichen Salzgewinnung in Österreich*, in: Stadt und Salz, ed. by Wilhelm Rausch (Beiträge zurGeschichte der Städte Mitteleuropas 10) Linz/Donau 1988, p. 76.

[10] *Tiroler Landesarchiv Innsbruck, Cod. 3176 and Cod. 3177*; cf. Srbik, *Salzwesen*, p. 43, n. 1.

[11] Rudolf Palme, *Die landesherrlichen Salinen- und Salzbergrechte. Eine vergleichen-de Studie* (innsbrucker Beiträge zur Kulturwissenschaft 34) Innsbruck 1974, p. 53, nr. 1 b.

[12] Palme, *Salinen- und Salzbergrechte*, p. 53, nr. 1 b: Srbik, *Salzwesen*, p. 43, n. 1.

[13] Cf. Srbik, *Salzwesen* p. 43, n. 1; Palme, Salzwerke, p. 60.

[14] Cf. Srbik, Salzwesen, p. 45.

[15] Wiesflecker - Rainer, Regesten II/I, p. 113, nr. 419.

procured the areas of the young Hirschberg along with the salt pans in Thaur near Hall, for 4000 Marks. [15] Perhaps at the time he bought the saltery Meinhard was already thinking of a substantial increase in production through the digging of a tunnel.

The bishopric in Augsburg, too, still had some rights to the new salt mine in Hall in Tirol, because the sovereign of the Tirol paid 50 Marks from the profits of the mine yearly to the bishopric until well into the XIVth century. [16]

Around the year 1292 Duke — later King — Albrecht I of Austria opened a saltery in the Gosau valley. [17] Since this was located on the border of the territory of the Archbishop of Salzburg, it was very inconvenient for the Salzburg sovereign because it was concerned about selling his own salt as free of competition as possible in northern Austria — the south of Austria was already supplied by the saltworks in Aussee. In 1293 an agreement was reached between Archbishop Konrad IV and Duke Albrecht, who renounced the profits of the saltworks in Gosau for three years before he then finally sold them for the sum of 3000 Marks. [18]

In the year 1311 Queen Elisabeth, a daughter of Count Meinhard II of Görz-Tirol and the widow of King Albrecht I, bestowed feudal tenures in the pan or salt-boiling works in Hallstatt to 12 citizens of Hallstatt. [19] On the basis of the formulation "daz wier mit vnsern gute von wilden gebirge vnd gruenen wasen gepawet und gestiftet haben" [20] it has been generally assumed that the mine in Hallstatt was developed at about this time. In reality however, it had already been mentioned in the year 1305, but this document was entered in the Upper Austrian "Urkundenbuch" (or Book of Documents) by mistake under the year 1315. [21] The Abbess of the Benedictine convent in Traunkirchen recorded in this document that at the request of Queen Elisabeth and her son Rudolf III the convent in Traunkirchen was given, namely, "von den hundert phunden, die man vns ierlich geit von dem sieden ze Halstat, daz da von dem Halperg chumt,

[16] Urbarium episcopatus Augustani de anno 1316, in: Monumenta Boica 34/2, München 1845, n. 360; cf. Palme, *Rechtliche Probleme*, p. 73; Franz-Heinz Hye, *Hall in Tirol. Gründung und Werdegang einer Salzstadt*, in: Stadt und Salz, ed. by Wilhelm Rausch (Beiträge zur Geschichte der Städte Mitteleuropas 10) Linz/Donau 1988, p. 236.

[17] Cf. Ferdinand Krackowizer, *Geschichte der Stadt Gmunden in Ober-Oesterreich* 1, Gmunden 1898, p. 146.

[18] *Salzburger Urkundenbuch 4: Ausgewählte Urkunden 1247-1293*, ed. by Franz Martin, Salzburg 1933, p. 212, nr. 172; cf. Krackowizer, *Gmunden* 1, p. 146.

[19] *Urkunden-Buch des Landes ob der Enns* 5, Wien, 1868, pp. 36-38, nr. 39; cf. Palme, *Salzwerke*, p. 63.

[20] *UB des Landes ob des Enns* 5, p. 36, nr. 39.

[21] *UB des Landes ob der Enns* 5, p. 138, nr. 143; cf. Emil Werunsky, *Österreichische Reichs- und Rechtsgeschichte. Ein Lehr- und Handbuch*, Wien 1894-1938, p. 249; Engelbert Koller, *Forstgeschichte des Salzkammergutes. Eine forstliche Monographie*, Wien 1970, p. 2.

vnserm convent ze Trounchirchen ze wesunderm trost alle iar, achtvndzwanzk phunt geben sol, ze irleicher chotemper siben phunt". [22] This proves without a doubt that the mine in Hallstatt was already in use in 1305. The opening of the mine in Hallstatt is certainly due to Queen Elisabeth; she received at least the sovereign rights over Hallstatt and vicinity in the year 1280 as a mourning gift. [23] It certainly cannot be denied that the development of the Hallstatt mine was a replacement for the abandoned saltery in Gosau. It was probably the same Knight Nikolaus von Rohrbach, who, had developed Hall in Tirol earlier, who dug the first tunnel in the Hallstatt mine at the order of Queen Elisabeth, or King Albrecht I of Austria, respectively.

The same procedure was observable in almost all the mines. Directly before or at the latest during the changeover from the exploitation of salt springs to mining, the saltworks were taken over by the respective sovereigns more or less forcibly. They apparently expected a sizable increase in profit for their treasure vaults if they possessed the mines. However, this was advantageous for the Austrian and the Salzburg mines as well. On the one hand, enough money was available to equip these mines generously; on the other hand, the transfer of technology between the Austrian mines generally functioned quite well. The exchange of expertise with the Salzburg mines was also relatively good since Austria was the only state in central Europe besides Salzburg and the "Berchtesgadner Land" that mined salt, and so the Archbishop of Salzburg was able to turn to the Austrian sovereign for any problems he had regarding salt.

The method of salt mining

One first drove horizontal tunnels from the surface into the interior of the mountain. These tunnels initially passed of course through rock with no salt, the work being carried out by the pitman, or hewer, using a sharpened chisel in one hand and a hammer in the other. The method of setting fires was often used in these alpine salt mines. [24] At the end of the tunnel one burnt a pile of wood making certain of adequate ventilation. By cooling off the heated rock quickly with a shower of water, the rock became brittle. This method was dangerous due to the formation of smoke gas, but made the pitman's job a lot easier. If there was danger of the brittle limestone breaking away from the ceiling or the walls, the

[22] Cf. Palme, *Salzwerke*, pp. 62-64.

[23] UB des Landes ob der Enns 5, p. 127, nr. 132; cf. Godfried Edmund Frieb, *Königin Elisabeth von Görz-Tirol, die Stammutter des Hauses Habsburg- Lothringen*, Wien 1890, p. 19 ff.

[24] We find "Hofwürcher" in Hall in Tirol the workers who had to set fires in the tunnels, cf. Palme, *Salinen- und Salzbergrechte*, p. 54, nr. 1 b.

tunnel had to be boarded i.e. lined with boards. [25] Once one encountered the so-called "Haselgebirge", a mixture of salt, clay and gypsum, leaching caverns were hewed out. These were large underground chambers with capacities of up to 12,000m³. [26] Then water was let in which leached the salt out of the rock, and one waited until the water was saturated with salt, i.e. had a salt content of 26 to 27°C. The residues settled on the floor of the cavern. At this point the saturated solution only needed to be bailed out, transported to the saltery and then heated until crystalline salt was left in the pans.

There are various theories concerning these leaching caverns. The oldest Austrian historiography assumes a three-stage development: [27]

Stage 1 consists in dry mining with the leaching process carried out above ground on the pieces of rock the miner hewed off. Stage 2 and 3 are evidently the extraction of the brine by means of underground leaching of the "Haselgebirge". This method, incidentally, continues to be used today in much the same way.

Stages 2 and 3 differ as follows: the older stage consists in the construction of leaching caverns. From a tunnel one sank a 20 to 30 m deep shaft — called a "Pütte" — which derives from the Latin word "puteus" (or: well). At the base of this shaft a leaching cavern was then hewed out. Fresh water was introduced into the cavern through the inclined shaft. Once the water had an optimal salt content of 26 to 27°C it was bailed out through the "Pütte" by means of a system similar to a draw-well. A wooden pipeline was then used to convey the brine out of the mine and on to the saltery's evaporating pans. [28]

While the leaching process ate away the ceiling and the walls of the cavern, the cavern floor became higher due to the accumulation of residues and the level of the brine increased due to repeated additions of water. The possibility of exploitation of such a cavern ended at the point when the brine level reached the working horizon, i.e. the original tunnel. [29]

Stage 3 consists in the construction of the leaching cavern in such a way that the brine can run off by itself. This was brought about by either a "gemeinen Dammwöhr", i.e. a "common weir" or "dam", or by the older "Hallein weir", in the following manner:

The leaching cavern, which was hewn out in the working horizon itself, was closed off on the tunnel side with a dam of sediment — one speaks of a "weir" in

[25] Cf. Erich Egg, *Schwaz ist aller Bergwerke Mutter*, in: Beiträge zur Geschichte Tirols, Innsbruck 1971, p. 265 ff.

[26] Cf. Wilhelm Günther, *Die Saline Hall in Tirol — 700 Jahre Tiroler Salz — 1272-1967* (Leobener Grüne Hefte 132) Wien 1972, p. 36.

[27] Cf. Aigner, *Salzbergbau*, p. 228 ff.; Srbik, *Salzwesen*, p. 34 ff.

[28] Cf. Herbert Klein, *Zur Geschichte der Technik des alpinen Salzbergbaues im Mittelalter*, in: Mitteilungen der Gesellschaft für Salzburger Landeskunde 101 (1961), p. 262.

[29] Cf. Klein, *Technik*, p. 263.

the restricted sense — and the brine drained off via some kind of a sieve into a wooden pipeline. Because of this dam, the entire cavern came to be called a "weir". Besides making the troublesome bailing of the brine unnecessary, the weir (or cavern) was advantageous because theoretically it could be continued throughout the entire mountain up to any height — in practice however it went only as far as the next tunnel. [29]

In a paper appearing in 1961 Herbert Klein expressed the opinion that the epoch of dry mining never existed in medieval salt mining at all. Except in the prehistoric period dry mining cannot be attested anywhere. On the other hand, the method of bailing brine out of a leaching cavern can be inferred so directly from that of salt extraction from salty springs that the roundabout way via dry mining appears extremely improblable. The leaching cavern is ultimately nothing more than a salt well sunk into the depths of a mountain. Natural spring salt was usually not extracted from independent springs appearing on the surface, but from artificially constructed well shafts which were sunk at the level of strata containing brine. The difference between the two consists in the fact that natural brine was bailed from the bottom of the well while the brine in the leaching cavern was created artificially by adding fresh water. [30]

Accordingly, we can assume that right from the beginning medieval alpine salt mining used the leaching process, namely that of the leaching cavern or artificial sink trap.

As regards the last stage, which utilized weirs or dams, this method was applied in the mines of the Austrian Salakammergut — that is to say in Hallstatt in Upper Austria and Aussee in Styria — only in the year 1575 and, as has been expressly said, according to the example of Hallein.

In Hall in Tirol the dam method was first used only in the year 1617. Even in Hallein itself, which must be considered the place where this method originated, such dams were used exclusively only after 1623. Prior to this, both leaching caverns and dams had been used for quite some time, but in such a way that the former were exploited until the brine reached the height of the tunnel, i.e. the point from which the brine was bailed out; then a dam was built and the brine drained off as described previously. [31]

This dam method can be traced back in Hallein to an amazingly early time. As early as the year 1268 a document speaks of a "structura" in the mountain. [32] Another document from the year 1271 not only mentions very clearly a dam in the present-day sense but one can also deduce the method described above —

[30] Cf. Klein, *Technik*, p. 263.

[31] Cf. Rudolf Palme, *Einflüsse der sich wandelnden Salzgewinnungstechnik auf Salzberg- und Salinenordnungen des späteren Mittelalters und der frühen Neuzeit*, in: Technikgeschichte 53 (1986), p. 2.

[32] *Salzburger UB* 4, p. 60, nr. 61; cf. Klein, Technik, p. 264.

namely the transition from a leaching cavern to a dam. [33] The provostry of Berchtesgaden at that time allowed the Salzburg Chapter of the cathedral to begin work on a salt mine on its property. Only one tunnel was allowed. Only if a cave-in occurred behind the construction commonly called a "wer" was the Salzburg Chapter permitted to drive a second tunnel higher up on the same property from which the caved-in area could be further exploited. This is evidently to be understood in the following way: the miners of the Salzburg Chapter drove a tunnel into the mountain and hewed out a leaching cavern, or sink-trap, respectively. At this time the rule was apparently a single leaching cavern per horizon. From a visitation report from Hall in Tirol in 1399 we know, however, that nine caverns were being used in three tunnels. But this was already 128 years later. Let us return though to Hallein in 1271. It is assumed that at a certain point the leaching cavern was modified to utilise a dam. The dam allowed the area above the tunnel to be leached analogously to the leaching cavern below the tunnel. If the above-mentioned catastrophe now occurred, it was permitted to drive a new tunnel higher up, from which a new leaching cavern could reach the caved-in area. That the contract of 1271 does not consider a cave-in during the time in which the leaching cavern of the original tunnel was still in use can be explained by the fact that in such a case a shaft could of course be sunk from another point of the same horizon. At that time the self-run-off feature of the dams was apparently not included in the planning one simply bailed out the brine over the dam, because one speaks of only one tunnel and not of a second one through which fresh water could be let in.

The apparently full utilisation of the dam method in the second half of the XIIIth century, i.e. still in the first century of medieval salt mining, shows that it must have been invented as a complement to the leaching cavern very soon after this first method was introduced. However, that the use of the dam method was restricted to Hallein alone for centuries can under no circumstances be explained by a lack of transfer of technological expertise from Hallein to Austria.

There were many experienced miners from Hallein working in Hall in Tirol or in Aussee. On the other hand, as we know from a mining directive stemming from the end of the XIVth century, 24 bailers were employed in Hall in Tirol. [34] It is probable that the self-run-off feature, as evinced in the dam method, was not yet perfected to the point that it could be applied in other salt mines.

When one began to add more and more tunnels to the alpine salt mines, and to branch off from existent tunnels, mine surveying became increasingly more important because of the natural danger of cave-ins due to the gigantic leaching caverns.

[33] *Salzburger UB 4*, pp. 71, f., nr. 72; cf. Klein, Technik, p. 264.

[34] Cf. Palme, *Salzgewinnungstechnik*, p. 2f.

The development of mine surveying

Because of their large size, the intersection of one cavern with another in these salt mines was nothing out of the ordinary. In was for this reason that numerous innovations in mine surveying came from the alpine salt mines. [35]

This development stemmed as well from Hallein's Mt. Dürrnberg, where each tunnel belonged to someone else and where, consequently, it was important that there were no intersections. However, the Archbishop of Salzburg had a sort of special property right over the entire saltmaking enterprise. Disputes concerning tunnels or leaching caverns were continually settled. We find on Mt. Dürrnberg already in the course of the XIIIth century the practice of measuring out on the surface the progress of the mine as surveyed underground in order to keep a check on the relationship of the tunnels to one another and their position with respect to the borders of the mine. For these tunnels plotted off on the surface there was even a special designation, "Tagschaftricht". To quote a document from the year 1266: "debita diei linea, que vulgo tagschaftriht dicitur". [36] This method presupposed considerable expertise in surveying.

In technical terminology one speaks of "Schinwesen" and means the art of surveying mines. Accordingly, the mine surveyor was the "Schiner", and the old surveying instrument the "Schinzeug". The unit of measure used for centuries in mines in Austria and Salzburg along with the "Klafter" and "Lachter" — which varied from mine to mine — was the so-called "Bergstabel". [37]

The oldest instruments for length measurement were cords, poles and staffs. Special measuring implements like the "Bergstabel" or "Bergklafter" were to be added later on. These were made of wood and indicated the length in "Klafters" or "Lachters" valid for the respective mining area — on the average about 2 m. [38]

[35] Cf. Rudolf Palme, *Die Weiterentwicklung des österreichischen Grubenver- messungswesens im Spätmittelalter und zu Beginn der Neuzeit*, in: Ingenieurvermessung von der Antike bis zur Neuzeit, ed. by Hartwig Junius (Vermessungsuesen bei Konrad Wittwer 16) Stuttgart 1987, p. 141.

[36] *Salzburger UB* 4, p. 56, nr. 56; cf. Klein, *Zur älteren Geschichte der Salinen Hallein und Reichnhall*, in: Viertel jahrschrift für Sozial- und Wirtschaftsgeschichte 38 (1952), pp. 306-333; reprint in: Beiträge zur Siedlungs-, Verfassungs- und Wirtschaftsgeschichte von Salzburg. Gesammelte Aufsätze von Herbert Klein. Festschrift zum 65. Geburtstag von Herbert Klein, mit einem Vorwort von Theodor Mayer (Mitteilungen der Gesellschaft für Salzburger Landeskunde 5) Salzburg 1965. p. 386.

[37] Cf. Franz Kirnbauer, *Die Entwicklung des Markscheidewesens im Lande Österreich* (Blätter für Technikgeschichte 7) Wien 1940, p. 17.

[38] Cf. Franz Kirnbauer, *Die "Wachsscheibenmethode" – eine Frühform bergmännischer Winkelmessung*, in: Berg- und Hüttenmännisches Jahrbuch 84 (1936), pp. 124-128; Michael Ziegenbalg, *Aspekte des Markscheidewesens mit besonderer Berücksichtigung der Zeit vom 1200 bis 1500*, in: Montanwirtschaft Mitteleuropas vom 12. bis zum 17. Jahrhndert.

The compass, which was necessary underground for exact orientation was used in the XIIIth century by Arabs and Vikings for seafaring, but it appears highly questionable whether the compass was already used at this time in mining. We encounter the term only in the year 1474 in reference to a Tirolean surveyor who, however, was employed in the silver and copper mines in Schwaz. [39] Beside the magnetic determination of angle and direction there was, much earlier both in ore and salt mining, a form of analogous angular measurement through the scribing of angles in wax discs. At the transition from medieval to modern times the surveying instrument appeared also in the alpine ore and salt mines.

This instrument combined angular and length measurement. It consisted of a main and a secondary instrument. Devices were attached for horizontal angles and plumb bobs for levelling. Both instruments were re-positioned alternately. Between the main and secondary instrument was a bubble level for measurement of the angle of inclination. All three adjustable dimensions — length, horizontal and vertical angle — were noted down in so-called "Schinbüchern", i.e. surveying books. One of the principal tasks of mine surveying was the pre-determination of distances when sinking shafts or driving tunnels. Here indirect methods could be used with the aid of cord triangles on the basis of intercept theorems and similar triangles. Using this method, certain lengths were placed in relation to one another. Progress was made especially at the beginning of the XVIth century when descriptive geometry was made an integral part of the art of surveying and used in mine plots for the representation of underground excavations. [40]

While we have hardly any available sources regarding the further development of mine surveying in Mt. Dürrnberg near Hallein in the XIVth and XVth centuries, we are able to observe this development well in Hall in Tirol particularly in the second half of the XIVth century, in the XVth and at the beginning of the XVIth century.

The relatively recent salt mine in Hall was of course breached by tunnel after tunnel each having several leaching caverns. However, the more tunnels were driven, the greater was the danger of cave-ins due to intersections of caverns.

A mining directive can be cited here with the title "Von dem perg durch kuning Hainreich gesetzt und geordnet". It allegedly originates from Duke Heinrich of Carinthia and the Tirol — he died in 1335 — who also liked to call himself the King of Bohemia. In this directive, the final modified form of which

Forschungsprobleme, ed. by Werner Kroker and Ekkehard Westermann (Der Anschnitt, Beiheft 2) Bochum 1984, pp. 40-49.

[39] Cf. Kirnbauer, *Markscheidewesen*, p. 31.

[40] Cf. Kirnbauer, *Wachsscheibenmethode*, p. 124 ff.; Kirnbauer, *Markscheidewesen*, p. 21 ff.; Ziegenbalg, *Markscheidewesen*, p. 41.

probably stems from just prior to the year 1472, the dimensions of the mine were laid down as well as how much rock had to be hewn out per week. [41]

A "Pütte", or vertical shaft, was supposed to measure three ells square. Since a Tirolean ell was about 0.8 of a metre, a "Pütte" would have a lateral section of 4.8 m^2. A tunnel was supposed to measure 3 by 1.5 ells, or about 2.9 m^2. A "Langoffen", which was a protective structure in the leaching cavern, was to be 1.5 Stabel by 2 ells in size. The "Bergstabel" in Hall in Tirol measured only 1.71 m. This mining directive shows us that people in Hall in Tirol at that time were at least familiar with length measurement. [42]

A report of the visitation of the Hall mine from the year 1399 is in Codex 3176 of the Tirolean State Archives in Innsbruck. [43] It is a copy, probably from the year 1462. According to this report, on 12 October 1399 Heinrich Fluehel, the Master (i.e. the managing official) of the Hallstatt mine in Upper Austria, Nikolaus Pressel, Master of the Aussee mine in Styria, and Roger Chun, also from the Aussee mine, visited the mine in Hall in Tirol at the order of the sovereign and gave all leaching caverns a thorough inspection. All Austrian salt mines at this time were in the hands of the Austrian sovereign. The exchange of technology among the Austrian mines was a matter of course. When the Hall mine became totally run-down due to the leases and pledges of the last Tirolean Counts, Duke Rudolf IV — the first Habsburg to rule over the Tirol after the extinction of the Counts of the Tirol — commissioned a Master from the Aussee mine to get the Hall mining operations running better. He evidently must have understood something of the art of surveying because throughout the entire late Middle Ages — in contrast to the ore mines — we find no surveyors in the Austrian salt mines.

The reason for the visitation of the year 1399 was probably the death of Master Hertel Chun, who had continued the line of Aussee Masters in Hall in Tirol in order to push through all the reform measures ordered by Duke Rudolf IV in about 1365. The visitation commission initially inspected the old tunnels and found nine leaching chambers, the sizes of which the visitation report describes exactly; one of the nine was no longer usable, four had been improved by Hertel Chun, and four were completely new. Afterwards, the commission inspected one of the new tunnels driven by Hertel Chun. It was expressly noted in the report that the new tunnel was not too close to the old one, so that there was no danger of a cave-in. However, the Hallstatt Master, Heinrich Fluehel, particu-

[41] *Tiroler Landesarchiv Innsbruck, Cod. 3177*, fo. 32^{v}—36^{r}; cf. Günther, Hall in Tirol, p. 18; Recording the date of this directive cf. Srbik, *Salzwesen*, p. 43 f. n. 1.

[42] *Tiroler Landesarchiv Innsbruck, Cod, 3177*, fol, 32^{v} f.; cf. Günther, *Hall in Tirol*, p. 18; Palme, *Weiterentwicklung*, p. 144.

[43] *Tiroler Landesarchiv Innsbruck, Cod. 3176*, pag. 67-70; cf. Palme, *Weiterentwicklung*, p. 144 f.

larly criticized Hertel Chun's carelessness in having the leaching chamber hewn out.

Even though the visitation report at no point mentions surveying work, we have to assume that the Masters From Hallstatt and Aussee utilized measuring devices since they could not have otherwise been able to determine the size of the leaching caverns. As well, the correct distance of the new tunnel from the old one could be established only through measurements. [44]

Maximilian I carried out new reform measures with regard to the Hall mine, which had been somewhat neglected by Duke Sigmund with the nickname "der Münzreiche". Duke Sigmund saw the salt mine primarily as a source of income and subcontracted the mine without keeping it up or making investments. Hall was now supposed to be a kind of example for the reforms of the other Austrian salt mines. In the XVth century the Hallstatt and Aussee mines were also increasingly sub-contracted and hence run-down. If, for example, the residue in the leaching caverns is not removed after the brine has been drained off, they are ruined after being used several times. If a tunnel was leased, pledged or loaned for a specific period of time, the person who had the rights during this period was obviously only interested in getting as much profit out of the tunnel as quickly as possible without investing a great deal. The persons who cleaned out the caverns also cost money and as a result a temporary owner who wanted to have work done as economically as possible within a short time was not prepared to hire cleaners.

Maximilian I expressly recorded in his "Amtsbuch", which was a kind of reform codification for Hall probably edited in the year 1505, that visitations of the mine were to take place twice a year — namely around St. George's Day, 24 April, and around St. Michael's Day, 29 September. [45]

The visitation was to make sure that each person was doing his job properly, that everyone in the Hall mine understood how to use a surveying instrument, to measure and to level correctly, that the leaching caverns were the proper size, not too close to one another and punctually cleaned, etc. The visitation commission was to consist of the "Salzmair", the highest official of the entire Hall saltworks, two officials of the municipal government in Innsbruck, two members of the Hall city council, the official judge of the ore mines around Hall, and the sworn surveyor from the silver and copper mines in Schwaz in the Tirol. [46]

[44] Cf. Palme, *Weiterentwicklung*, p. 145.

[45] *Tiroler Landesarchiv, Cod. 3178*; cf. Julius Trubrig, *Die Organisation der landesfürstlichen Forstverwaltung Tirols unter Maximilian I.*, in: Forschungen und Mitteilungen zur Geschichte Tirols und Vorarlbergs 3 (1906), p. 324 ff.

[46] *Tiroler Landesarchiv Innsbruck, Cod. 3178*, fol. 158r; Palme, *Salinen-und Salzbergrechte*, p. 58. nr. 2.

More refined surveying methods were now increasingly used in Hall to exploit more intensively the mine in keeping with the with the wishes of Maximilian I. It was for the same reason that the sovereign ordered the entire mine to be thoroughly surveyed by Master Kaspar Haimel in 1506, so that it would be possible to see where new tunnels could be driven. This survey was to take 14 days. [47] It is a fact that at the beginning of the XVIth century — under Maximilian I — Hall was leading in the field of mine surveying methods. In Hall in Tirol people understood not only how to use the surveying devices that had only just been invented, but also how to use the compass, a device which even one hundred years later was not understood in Hallstatt and Aussee. For these reasons Tirolean Masters had to travel very often to the Salzkammergut in order to explain the compass to surveyors in Aussee and Hallstatt as stated again and again in the mandates of the sovereign. [48]

It is no wonder then that the oldest mine plot of the entire German-speaking area — and probably of all Europe — is traced to Hall in Tirol in the year 1531. Entered on this plot are true-to-scale measurements carried out with the compass and surveying instruments and the corresponding lengths in "Bergstabel". Not long after this, in 1534, another true-to-scale plot was drawn of the Hall mine. It can be seen from these plots that around the year five horizons were in use, with workings amounting to some 13,800 m connected by several trial pits. [49]

We have already heard about the high state of the art of surveying in Hallein in the XIIIth century. Unfortunately, from the XIVth to the beginning of the XVIth century we have extremely little available source information. From the XVIth century we have very old plots of the Mt. Dürrnberg mine, namely a fragment of a plot from the year 1536 recording a part of the upper workings, and a master mine plot from the year 1554. [50]

The Austrian salt mines in Hallstatt and Aussee, which were leading in terms of technology up to around the middle or end of the XIVth century, were subjected primarily in the XVth century to a period of sub-contracting which inhibited any technical progress whatsoever. It was only after the reforms of Maxi-

[47] *Tiroler Landesarchiv Innsbruck, Kopialbuch "Embieten und Befelch" 1506*, fol, 417; cf. Palme, Weiterentwicklung, p. 146.

[48] Österreichisches Staatsarchiv, Finanz- und Hofkammerarchiv Wien, Innerösterreichische Miszellen, rote nr. 156; cf. Carl Schraml, *Das oberösterreichische Salienenwesen vom Beginn des 16. bis zur Mitte des 18. Jahrhunderts* (Studien zur Geschichte des österreichischen Salinenwesens 1) Wien 1932, p. 141; Palme, *Weiterentwicklung*, p. 146.

[49] Cf. Franz Kirnbauer, *Die Entwicklung des Grubenrißwesens in Österreich*, in: Blätter für Technikgeschichte 24 (1962), p. 65; Günther, *Hall in Tirol*, p. 25.

[50] Cf. Klein, *Technik*, p. 266.

milian that these two mines sought closer contact with Hall for the purpose of exchanging expertise. [51]

In both mines it had probably been customary since the beginning of the XIVth century to mark off the actual lengths and angles of the underground survey above ground on a flat field or during the winter on a frozen Salzkammergut lake. Contemporary surveyors called this "Zulegen". Such a practice provided not only a good, clear picture of the underworkings, but also the required holing-through distances or directions immediately in true scale and without difficult calculation. In the opinion of Franz Kirnbauer, this method of making or laying out a mine plot in full scale in the open on a flat area is an Austrian invention. In Aussee, for example, where the use of the compass was not understood despite constant instruction by Hall experts, this practice was continued on into the XVIIth century. [52]

Work in the salt mines

We are well informed about this subject by a mining directive entitled "Die recht und gesezt des pergs" for Hall in Tirol at the end of the XIVth century. [53] According to this, as has already been mentioned, the Hall mine was supervised by a Master. His next in command was the "Schaffer", equivalent to an "overseer" or "foreman".

At the head of the work force were of course the pitmen, or hewers, who earned 18 groschen per week, three groschen going to their helpers. If one considers that a pitman in Schwaz in the Tirol at the beginning of the XVIth century earned one gulden per week, this was about half of what he earned a century later in Schwaz due to the high rate of inflation. [54] The pitman drove tunnels or sunk shafts, hewing away a specified amount of rock each week. His helper had to carry this away.

Timbering too was apparently specialised work, and was carried out by a so-called "Rüster", in present-day parlance a "timberman". Connected to this work there was also the work of the "Hofschmiede", or "blacksmith", who was responsible for the metal bracing of the timbering and for forging the implements used by the pitmen and the timbermen. The next group of workers we encounter is

[51] Cf. Schraml, *Salinenwesen*, p. 141; Palme, *Salzwerke*, p. 428; Palme, *Weiterentwicklung*, p. 147.

[52] Kirnbauer, *Grubenrißwesen*, p. 74 f.

[53] *Tiroler Landesarchiv Innsbruck, Cod. 3176*, pag. 26-31; Palme, *Salinen- und Salzbergrechte* pp. 53-56, nr. 1b.

[54] Cf. Palme, *Salinen- und Salzbergordnungen*, p. 54, nr. 1b; to Schwaz: Egg, Schwaz, p. 272.

that of the "Hofwürcher", whose job was to bring firewood into the mine for the purpose mentioned earlier.

Also mentioned in this mining directive are "Schöpfer", or "bailers", who had to bail the brine out of the leaching caverns; then "Säuberer", the "cleaners" who were responsible for cleaning out the leaching caverns after the brine had been bailed out or drained off; finally, there was the "Wasserhüter", who maintained the wooden pipeline which transported the brine down to the saltery. [55]

The difficulties caused by the long march to the mine — in Hall in Tirol from an altitude of 600 up to 1500 metres — were avoided by having the miners sleep during the week in huts built just outside the tunnel entrances.

According to the estimations of the last manager of the mine in Hall, Wilhelm Günther, at the end of the XIVth century the mining personnel numbered some 125 men. Considering the circumstances at that time, Hall was undoubtedly one of the larger undertakings. [56]

However, not all of these 125 men worked exclusively in the mine. As a rule, they lived on a small farmstead near Hall, that is to say, in Absam, in Thaur and in Volders. [57]

Normally, the miners received a wage or a "salarium statutum" only in those periods in which salt was boiled in the saltery. There were only a few jobs other than this which were remunerated at all times. During the weeks in which for whatever reason salt was not boiled, the workers in the mine, like those in the saltery, received only a small percentage of the regular wage; in the account books of the Tirolean sovereign, where once a year the "Salzmair" had to account for income and expenditure, this sum was designated summarily as "extraordinaria". An "extraordinarium" amounted to one fifth of the normal wage. If during the year the saltery worked only 20 weeks, the workers of course needed another source of income to maintain a minimal existence. Under these circumstances it is clear that the workers were interested in keeping the idle periods of the saltery down to a minimum. [58]

The causes of these idle periods could be extremely varied. Normal working holidays were at Christmas, Easter and Whitsun. Other causes can be attributed to Acts of God, as for example when the Hall valley was flooded by snow water ("proper inundacionem nivis"), making it impossible for the miners to ascend to the mine on Monday morning. At the same time the fire in the saltery had to be put out whenever a strong föhn wind blew, because due to the short chimneys the wind could cause a disastrous fire ("proper ventum"). A further Act of God

[55] Cf. Palme, *Salzwerke*, p. 170 ff.

[56] Günther, *Hall in Tirol*, p.21.

[57] Cf. Palme, *Salzwerke, p. 229.*

[58] *Cf.* Rudolf, Palme, *Die soziale und wirtschaftliche Stellung der Haller Bergknappen bis zur Mitte des 14. Jahrhunderts*, in: Tiroler Heimat 37 (1974), p. 119.

was when avalanches roared down the valley and destroyed the pipeline. We can read in an account book at the beginning of the XIVth century: "Et due ebdomande vacaverunt propter lavinas nivium in monte, que frangerunt cannes aque". [59] Sometimes of course the "Salzmair" had to shut down work in the saltery due to defects in the pipeline or the pans, etc.

Another reason for idle periods, which, however, cannot be attributed to an Act of God, was the use of the pitmen in times of war and feuds. [60] The pitmen, or for that matter the entire mining personnel, were probably viewed as subservient to the sovereign — during work they were directly subordinate to the jurisdiction of the sovereign — so that the sovereign could command their services as he saw fit. If there were too few soldiers available, the sovereign simply made use of his mining personnel.

As a result of the numerous financial strains on the saltworks, at the beginning of the 1340's the "Salzmair" was not able to pay the wages of the workers. On the occasion of the presentation of the accounts on 23 April 1340 we read: "Ex hiis dederunt operariis ex salario statuto per ebdomadas XLV marc. DCCCCXI, lb. II 1/2 et super hoc dicti operarii debent habere salaria statuta III". [61] At that time, then, "Salzmair" owed his workers four weeks' wages.

Regarding the presentation of the accounts, which Schine von Florenz made on 9 May 1341 as "Salzmair", we read: "Item dedit operariis unum salarium retentum de anno preterito Vero n. marc. XX, lb, II 1/2". [62] According to this, three weeks of the previous account period were still outstanding. In subsequent accounts we can find numerous examples of unpaid wages for both the miners and the workers in the saltery.

The financial difficulties besetting the "Salzmair" were simply passed on to the work-force. These conditions naturally contributed to the growing discontent among the workers who had by this time developed a sense of corporate pride. For example, in the year 1342 on the occasion of the presentation of the accounts Schine von Florenz notes: "Et una ebdomada vacavit ex lite, que vertebatur inter montanos et Schinonem, et eadem ebdomada debent montanii respondere". [63] According to this, then, there was discord between the miners and

[59] *Tiroler Landesarchiv Innsbruck, Cod. 288*, fol. 5[r] ff.; cf. Franz, Bastian, *Oberdeutsche Kaufleute in den älteren Tiroler Raitbüchern (1288-1370)* (Schriftenrihe zur bayerischen Landesgeschichte 10) München 1931, p. 46.

[60] *Tiroler Landesarchiv Innsbruck, Cod. 288*, fol. 45[r]; cf. Ludwig, Schönach, *Beiträge zur Geschichte der Saline Hall im 14. Jahrhundert*, in: Neue Tiroler Stimmen 48 (1908), nr. 152.

[61] *Bayerisches Hauptstaatsarchiv München, Tiroler Cod. 15*, fol. 20[r]; cf. Palme, *Haller Bergknappen*, p. 120.

[62] Bayersches Hauptstaatsarchiv München, *Tiroler Cod. 15*, fol. 30[r].

[63] Bayerisches Hauptstaatsarchiv München, *Tiroler Cod. 15*, fol. 72[r]; cf. Palme, *Haller Bergknappen*, p. 120f.

the "Salzmair". Any possible arrangement as to a course of action by the miners certainly had to be made in secret. We read again and again that it was forbidden for all the workers of the entire saltworks to unite. Such a prohibition depended of course on the subservient position of the miners. But let us pursue the disputes further for a moment. The rendering of accounts of 7 December 1345, which is, by the way, the last by Schine von Florenz, informs us more clearly about the real reasons for the dispute between the miners and the "Salzmair" Here we read: "Ed est notandum, quod in predictis ebdomadis XXXVIII ebdomade quinque vacaverunt ... quarta ebdomanda propter litem montanorum, qui ab officio non poterant habere precium quinta ebdomada officii denariorum defectum". [64] In view of this situation, in modern terminology we would talk about a "wildcat strike". Yet decisive for this cessation of work — which is the case here — was not demands for higher wages on the part of the miners, nor just the absence of wage payments due to a lack of money of the "officium", the official aministrative board of the Hall saltworks. The discontent of the miners did not develop overnight, but more likely had its roots in the mismanagement of the sovereign at that time, Margrave Ludwig von Brandenburg. [65] Another probable reason was the increased number of idle periods in the saltery. For example, in 1303 the saltery was idle for 4 out of 61 weeks.

In 1338 this increased to 6 out of 45 weeks, and in 1341 as many as 12 out of 52 weeks. The "Salzmair" of course had to give reasons for these idle periods in his account. In the first half of the XIVth century we observe a constant increase in idle periods "ex mandato domini". Hence whenever money was lacking to pay the workers, the sovereign simply closed down operations in the mine and the saltery. When this mismanagement, which was mainly at the expense of the miners, threatened their existence and wounded their sense of corporate pride, they simply began to strike. It would appear that the miners, or at least some of them, were organised in some kind of unofficial way since a strike presupposed an arrangement. In the week subsequent to the strike week, work was not allowed since the "officium" still had no money for wages. In modern terms, a "shutdown" followed the strike. In this context it may be interesting to note that the workers received an "extraordinarium" for the fifth week the saltery was idle, but nothing for the strike week.

The fact that this wildcat — and probably relatively spontaneous — strike took place indicates the considerable self-awareness and pride of these miners in Hall in Tirol. In particular the skilled miners, i.e. the pitmen and timbermen, etc., were evidently already well aware of their irreplaceability. Perhaps it was precisely the skilled workers who brought the unskilled workers into the strike.

[64] *Tiroler Landesarchiv Innsbruck, Cod. 288*, fol 23r.

[65] Cf. Palme, *Haller Bergknappen*, p. 121 f.

In any case, the strike had no apparent consequences for the workers. The sovereign presumabily had to admit to himself that he was the cause of the strike. [66]

The strike itself, however, also indicates the relatively good economic conditions in connection with the irreplaceability of the miners. For, after all, the miners risked an extended idle period of the saltworks during which the sovereign could get workers from other mines.

It can be seen from directives from Maximilian I regarding pitmen that the miners were still considered to be subservient. Additionally, they were forbidden any form of unification or alliance, and during the week each man was to go to his own hut and not to another one. They were not to play games, even card games, or indulge in other activities since these things hindered their sleep and relaxation. No worker was to borrow or buy anything from a fellow worker, but was to bring along enough food and other necessary things on Monday to the mine to last the entire week. This directive was of course intended to prevent disputes.

Despite the solidarity shown by the miners during the strike of 1345, there were still considerable social differences within the work force. It was mentioned, for example, that a helper earned one fifth of what the pitman earned. Maximilian's directives are probably to be understood in the sense that he endeavoured as much as possible to prevent social tensions among the various groups of workers. [67]

It has already been mentioned that the relationship of the sovereign to the miners was not a pure wage relationship, even though a formal contract apparently existed between the "officium" and the miners. At least the pitmen were continually enlisted for military service. The legal form of the contract was certainly that of a contract of employment in which authority and subordination played a very important role. Subordination to the sovereign during work was more or less equivalent to a position of servitude.

Every Monday morning, probably from the founding of the saltworks, the miners hiked up into the Hall valley to the mine, where they stayed the entire week until Friday evening. They worked a six-hour shift and spent their free time during the week in their huts. Only on Friday evening did they return to their homes around Hall, a hike of some two to three hours.

If at least the skilled workers managed to live thriftily, they were able to achieve a certain degree of prosperity. One way of doing this was through the buying of the rights for the exploitation of a tunnel. If a pitman had the rights to several tunnels, he could retire with a pension. [68] Without a doubt, the ances-

[66] Cf. Schönach, *Saline Hall*, nr. 153; Palme, *Haller Bergknappen*, p. 124 f.

[67] *Tiroler Landesarchiv Innsbruck, Cod. 3178*, fol. 156r - 159v; Palme, *Salinen- und Salzbergrechte*, pp. 56-59, nr. 2.

[68] Cf. Palme, *Haller Bergknappen*, p. 123 f.

tors of many a prosperous citizen of Hall in the XVth century earned his wage as a pitman. The reason why the pitman earned so much was not due to any social feeling for the skilled workers on the part of the sovereign, but simply due to their irreplaceability. They did something which no one saw, something which therefore was very simply mysterious. At the same time, of course, the work underground was very hard. In addition, it was often the case that skilled miners were lured away by other mines, so that the sovereign paid them a relatively good wage from the start.

Concluding remarks

In the alpine region salt deposits appear in only a few places, and there only in the form of the leached residue of a salt-bearing mountain. If one therefore had an indication that a large "Haselgebirge" existed here or there — and such sporadically appearing salt springs gave such an indication — then one dug at that spot until the deposit was reached. Since the Middle Ages the method of mining has undergone considerable changes to the extent that now dynamite is used to blast out larger section of rock. Hammer drills have replaced hammer and chisel. However, almost completely unchanged since medieval times are the leaching caverns, which are still used today in Austria. The advantage of the underground extraction of salt by means of leaching caverns is that one always had saturated brine for the pans. One hence avoided the concentration of the brine by means of various complicated processes. It was therefore always profitable to develop an underground salt deposit. Directly following the discovery of a salt deposit or even a salt spring the authorities were on the spot immediately and appropriated the area, in some cases forcibly.

Development of such deposits was of course much more expensive than exploiting a salt spring. However, since the sovereigns of both Austria and Salzburg expected gigantic underground deposits, they did not shrink from the initially high investment costs and later labour costs. They also wanted of course to secure the provision of the population in their respective territory with this vital commodity, i.e. to enjoy a monopolistic position in no way dependent on salt imports and, as a result of this, to enjoy more latitude with respect to foreign policy.

A further prime advantage of the saltworks being under the control of the sovereign was the transfer of technological information from one saltworks to another. As soon as an innovation was introduced in one, the sovereign was very keen on having it passed on to the others. There was no every-man-for-himself attitude and narrow-mindedness on the part of the numerous partners as we so often find in the case of salt springs. Hence for these and other reasons the legal structure of the alpine saltworks was very uniform.

Nevertheless, a salt mine was much more cost-intensive than a salt spring, primarily because of labour costs. It was for this reason, regardless of the rich deposits still available, that the salt mine in Hall in Tirol was shut down in the year 1967. And it was for the same reason that the mine in Hallein was closed this year. The national central executive board of the Austrian saltworks argued that there was enough salt for the Austrian population for a number of decades in Hallstatt, Aussee and Bad Ischl, the latter mine having been opened only in modern times. The closure of the Hall mine is already causing the city authorities problems. First of all the drinking water is becoming increasingly saltier because Hall's drinking water comes from natural reservoirs in the Hall valley, and secondly because it is feared that the mountain, which has been hollowed out, could one day collapse, causing a landslide which could destroy Hall.