"The Lithographic Stone Quarries of Bavaria, Germany"

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(Additional online resources about lithographic stone is available after the article.)

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"About midway between Munich and Nurnberg, Bavaria, on the Altmuehl, a tributary of the Danube, are some of the most valuable and interesting quarries in the world. They are the quarries of Solenhofen, Moernsheim, Eichstaett, and Kelheim, famous for an unusually fine variety of limestone, which is known as lithographic stone.

"Though the Solenhofen quarries were worked by the Romans, and though there are at present upward of three thousand men employed in them, they show no signs of exhaustion.

"In early times the thicker stones obtained were used for building purposes and the thinner ones for tiling of roofs and floors, for table tops, etc., and to-day, through all that region, there is hardly a house that is not built and tiled with these stones. But sixty years ago it was discovered they were more valuable for other purposes than in building. One Senefelder, a poor German playwright, one day, not finding any paper at hand, wrote on a polished piece of the stone from Kelheim, which he had purchased for grinding his ink, a wash list for his mother. Returning next day and seeing the writing, it occurred to him to try the effect of acid on the stone, as he had been seeking to find a cheep method for copying his plays. In five minutes the acid had eaten away one one-hundred-and-twenthieth of an inch of stone, where it was uncovered by the greasy ink, and Senefelder found that he could print copies that were quite legible though not very delicate. After several years' work he succeeded in perfecting this process, was pensioned by the King of Bavaria and lived to see the art of lithography perfected.

"After this discovery these quarries increased enormously in value, for they contain by far the best lithographic stone in the world. And this is one of the reasons why the Germans do the finest lithographic work that is done by any artists in the world.

"True, some lithographic stone is found in England, France and Silesia, and some from the Cretaceous formation on the celebrated Mount Parnassus in Greece and the Upper Carboniferous of the Volga River, the Carboniferous of Missouri and Illinois, the Subcarboniferous (barren limestone) of Kentucky; the Lower Silurian (Bird's Eye) of Canada contains some deposits; and beds have been reported in Virginia, Indiana, Arkansas, and Texas. But these are all of a quality much inferior to the Bavarian stone; and the American occurrences are so poor that none are worked for lithographic purposes, consequently the United States imports the quantity it uses to the amount of $100,000 yearly.

"With all the miles of territory, all the geological strata and different varieties of rock that the United States possesses, it is more than probable that she has good lithographic stone. The reason that it has not been discovered is to be found in the fact that it has not been searched for by men who understand the characteristics and qualities desirable. The discovery of such

quarries would well repay the effort. The Bavarian lithographic stone occurs in the upper division of the 'White Jura' or 'Malm,' as the formation is called in Germany, or 'Upper Oolite,' as it is called in England and France. The formation is peculiar in that it was deposited in troughs, so that it lies not above but lower than the sides of the 'Franconian dolomite,' which preceded it in order of deposition.

"The mass consists of almost pure carbonate of calcium, slightly mixed with silicous clay, dolomite, and bitumen. It is remarkably homogeneous and fine grained, generally of a gray or light cream color, and can be split into plates several feet square of a uniform thickness, which varies from seven inches to one-twelfth of an inch. This capability of being divided into large sheets as thin as pasteboard is a quality rare in any stone except slate, and hence these stones are often called lithographic slate, although they are limestones.

"After examing the quarries at Solenhofen and Moersheim I went to Eichstractt, to the quarry of Mr. Ehrensberger, where I found stone occurring in layers of from three-eighths to three-quarters of an inch in thickness, and of remarkable uniformly fine grain, superior even to that of Solenhofen and Moernsheim for lithographic plates and multiplying apparaturs. So excellent are these stones, and so easy to quarry, and so light to transport, that it is not surprising that they supply the markets of the world, and that the United States imports them in such great quantities.

"The quarrying is very simple, for no blasting is necessary. The layers are so loose that they can be removed with shovel and pick. Little machinery is needed to handle them, as plates of large dimensions are not wanted. The stones are trimmed with small hammers and chisels and polished with sand and water. The harder layers, used for the finest work, are afterward polished with pumice, and for chalk drawing and graduated tints are given an artificial grain with ground glass.

"At Mr. Ehrensberger's quarry at Eichstaett, below the surface soil are (a) six feet of silicious limestone; beneath which lie (b) ten feet of thin-layered argillaceous limestone, followed by (c) thirty-two feet of the hardest layers called 'Flinzschichten.' There are about thirty-eight of these latter layers, which are composed of about four hundred plates. Of these plates thirty-four are suitable for lithographic purposes. The whole series are laid out as level as a floor. Underlying them is a base of irregularly deposited limestone masses which rest on the Franconium dolomite. The roof of the shop has the characteristic tiling.

"In another way than in its uses in the fine arts and printing is this famous stone financially important, and that is in its returns to the quarry owners for the sale of scientific material which it has inclosed within its layers.

"The fossils that it contains have been sold for thousands of dollars. For one specimen (Archæpteryx) the British Museum paid $3,500, and the Berlin Museum for another of the same kind $5,000, and thousands of less high priced specimens have been sold.

"But this financial interest is nothing compared to the great scientific importance of the store of extinct animals that have been preserved through so many ages, and now give a vivid picture of the animal and (meager) plant life of that country at that time. The conditious (sic) of preservation in this region were unusual. 'When we,' says Prof. Zittel, one of the most famous of European laeontologists, 'recognize in the lithographic stone distinct impressions of Medusæ (jelly fish), whose bodies consist merely of soft jelly, and as a rule disappear like a breath when

the animals die; when numerous Libelluæ (dragon flies) and other insects have impressed thereon even the finest lineaments of their delicate wings; when long-tailed crabs are found in the stone with complete feelers and legs; when naked cuttlefish have left distinct contours of their bodies, then we must certainly agree that there must have existed conditions of preservaton such as we can scarcely expect to find in another place.'

"And because of these fine conditions of preservation and remains of more varities of animals than are contained in the best zoological garden in the world have been here preserved. More than 500 different species have been found in such perfect condition that they can be thoroughly studied and understood. Had it not been for the remarkably quiet condition of these inland seas and the slow deposition of the unusually fine homogeneous sediment which they contained, the delicate parts of many animals and many fragile species would have been destroyed, and thus important facts which aid in establishing brilliant and helpful theories would be wanting.

"Among these fossils one of the most famous and interesting is Archæapteryx, an animal which supplies one of the much demanded and long sought 'missing links,' for it has the general appearance and structure of a bird and a covering of feathers which are strikingly preserved on the wings and tail. But it has the teeth of a reptile, and its tail consists of twenty vertebræ, as does the tail of no bird. There are two feathers to each vertebra. Of the two Archæapteryx that have been found, one is in London and the other in Berlin, as mentioned before. They are pictured in most geologies.

"Hardly less interesting, but of much more common occurrence, are different species of the Pterosauria (flying lizards). Some excellent specimens of them have lately been found.

"The Pterodactylus, i.e., winged-fingered, was a peculiar flying reptile, which varied in size from that of a sparrow to that of an eagle. It also was one of the missing links, representing as it did animals that had teeth and other parts of skeleton like those of a reptile; head, general form and pneumatic bones of a bird; naked or furry body and wings like those of a bat, which is a mammal. This specimen is well preserved. The head, thrown back in a position usual in these fossils, shows the teeth quite plainly; the shape of the jaw bones, the large eye cavity, and all parts of the body, except the wing, are seen.

"The 'bill-muzzle' greatly resembles the 'wing-fingered,' but differs in having a long tail and a rounder beak. The wings of the two, however, are alike, consisting not of feathers, but of a thin narrow membrane, supported by the greatly prolonged little finger, which is four jointed and twenty-five times as long as the other fingers. The finest Pterodactylus ever found was the first one found. It was taken from the Eichstaett quarry in 1784. Since then a number of beautifully distinct examples have been obtained, and the greater number of them are now in the museum at Munich.

"A Homeosaurus shows all that remains of an animal that was once very like a lizard, and whose nearest descendants to-day are the sphenodous, which live in New Zealand. Ribs, vertebræ, fins, and some of the head bones can be clearly distinguished.

"But the most commonly occuring fossils are the fish, which are present in fine condition and large numbers.

"There is a Spathobatis, one of the 'Eagle Rays.' The depressed body is given triangular shape by the broad pectoral fins, which are closely joined at their base to the body. The ventral and caudal fins also are well shown in this example.

"A fish very often found is Caturus, a species belonging to the same order as the dog fish, but resembling the salmon in form and size. Some examples found are more than three feet in legnth. In this specimen the head bones are distinct, and the scales and fins well preserved.

"Another fish characteristic of this rock is Pholidophorus, one of the Lepidostean fishes, which have thick enamel scales shaped like rhombohedrons. Their arrangement in rows and the large dorsal fin are beautifully preserved in this specimen.

"In the waters which formed these rocks crabs were present in large quanties and in many varieties. Among them are Aeger, the long-tailed crab with complete antennæ and legs; and Limulus, the horseshoe crab; Eryon; Penaeus, shrimps, Palinurina; Eryma, etc.

"A partial list of the animals found in these strata would embrace, among those not already mentioned, dragon flies, ammonites, belemnites, star fish, jelly fish, earthworms, various shell fish, algæ, remarkable not more for their number than for the state of their preservation. A view of these fossils is enough to show how valuable are the gifts which these quarries have contributed both to art and science, and have added to the knowledge and happiness of mankind.

"– Stone."

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For more information on the Lithographic Stone Quarries of Bavaria and lithographic limestone, you can visit the links below:

"**Lithographic limestone**" (Wikipedia)
https://en.wikipedia.org/wiki/Lithographic_limestone

"**Solnhofen limestone**" (Wikipedia)
https://en.wikipedia.org/wiki/Solnhofen_limestone

"**Fossils of the Solnhofen Limestone – A Jurassic Konservat Lagerstätte in Germany**," presented by the Virtual Fossil Museum: Fossils Across Geological Time and Evolution.
http://www.fossilmuseum.net/Fossil_Sites/solnhofen/Solnhofen_Lagerstatt.htm

"**The Solnhofen Limestone of Germany**" (Localities of the Jurassic), Source: Barthel, K.W., Swinburne, N.H.M., and Conway Morris, S. 1994. Solnhofen: *A Study in Mesozoic Palaeontology*. Cambridge University Press, Cambridge.
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"**The story of the excellent litho stones from the French quarry of Maurice Dumas (MD)**," written by Hugo Bos. (Presented on the Polymetaal Printing equipment and Supplies, Netherlands)
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"**American Lithographic Stone**," in *Universal Engineer*, Universal Craftsmen Council of Engineers of the World, 1917, pp. 431-434. (Includes the following photo captions: "Getting out the rough blocks of American lithographic stone at the quarries in kentucky" (pp. 431); "Cutting American Lithographic stone into slabs." (pp. 432); and "Finishing the stone block at the plant of the Kentucky Kuthographic Stone Company." (pp. 433)
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