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The Colossi of Memnon Revisited

Recent research has established the source of the stone of the two 720-ton statues at Thebes.

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The two colossal statues usually referred to as the "Colossi of Memnon" are prominent features on the western plain of Thebes in Upper Egypt (Fig. 1). The impressive dimensions of the colossi, the quality of the stone, the technology involved in moving them to their present location, and the desire to determine the exact sources of the stone have been the primary reasons for continued interest in the statues. However, the location of the quarry sources, the weights of the statues, and even their dimensions have been matters of disagreement for a long time. In this article we describe the results of field and laboratory investigations that we undertook in an attempt to resolve these questions. To determine the provenience (place of origin) of the rock, which to us was the most important problem, we used neutron activation analysis to obtain elemental composition patterns of samples from the colossi which could be compared with the composition patterns of samples from different quarries (*1*).

The colossi are seated representations of King Amenhotep III (14th century B.C.), with smaller figures of members of his family forming part of the monument. Originally each of the colossi were monolithic, and they stood in front of a sumptuous mortuary temple of the monarch. The temple was destroyed soon after it was built. The statues are made of ferruginous quartzite, probably the hardest stone used for large sculpture in antiquity, and they rest on pedestals of similar material. The quartzite is distinguished not only by its hardness—greater than that of diorite—but also by its beauty and its ability to take on a high polish. There are about six quartzite quarries known in Egypt from which the stone might have been derived; the nearest of these is about 60 kilometers upriver from Thebes. Some of the quarries, however, may not have been able to produce blocks of the size and quality considered suitable for making the statues by the ancient Egyptians.

In antiquity, the colossi acquired fame by a curious development. In 27 B.C. an earthquake toppled the upper half of the northern colossus to the ground (*2*); thereafter in the early morning, strange sounds began to issue from the truncated statue. In contemporary reports these sounds are variously described as sounding like human voices, wind instruments, breaking harp or lyre strings, trumpets, and the sound of clashing cymbals. At this time

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the broken statue was identified with Memnon, son of Aurora, goddess of dawn, a Homeric hero killed at Troy by Achilles, and the sounds were interpreted as Memnon greeting his mother when she appeared (*3, 4*). This phenomenon attracted many visitors, including some of the highest rank such as the Roman emperor Hadrian and his retinue. Many of the visitors who heard Memnon speak carved statements, comments, or poems in Greek or Latin on the accessible surfaces of the statue; these graffiti in time aroused almost as much comment as the statues themselves (*5*). Just before the turn of the 3rd century A.D., the Roman emperor Septimius Severus reconstructed the broken colossus with five courses of stone resembling the rock used for the original statue. The reconstruction, however, stopped the sounds and with that, the flow of visitors, and the graffiti.

This historical episode relates to our study in that it was instrumental in giving rise to a considerable literature which includes descriptions and illustrations of the colossi; it also raises the question of provenience of the rock used in the Roman reconstruction.

The first modern travelers to mention the colossi were Father Protais and Father Sicard in the 17th and early 18th centuries. The Danish naval captain Frederick Norden and the English clergyman Richard Pococke were next in the 1730's. The accounts of these and other early travelers were particularly noteworthy by virtue of their great divergences as regards the nature of the stone and dimensions of the statues. The later reports became more factual, and features of scientific interest were more carefully recorded. Nevertheless, recent compilations (*4, 6*) still give a considerable range in the measurements and estimates of even such basic parameters as the height and the weight of the statues. The nature of the stone and its provenience also are subject to considerable controversy, even in relatively recent literature, and only one published speculation of how the statues were brought from the quarry to their present location exists (*7*, pp. 96–98).

Our main objective was to establish the source or sources of the rock from which the statues were made and to determine their size and their weight. We also hoped to find some evidence of the means by which the statues were brought to their present location.

Size and Weight of the Statues

A wide range of values is given by earlier workers for the height of the statues. Lepsius (*8*) gave the height as 14.28 meters; Wilkinson (*9*) as 14.55 m; Brugsch (*10*), perhaps adding the height of the pedestals to that of the statues, said they were "nearly 69 feet" (20.8 m) high. Jollois and DeVilliers, members of Napoleon's scientific commission, stated that the statues were 15.59 m high (*11*, p. 159).

In 1971 and 1972 we made careful measurements of the statues, especially of the southern one, which is most nearly complete. The upper half of the northern statue (the "vocal Memnon") is reconstructed, but the lower part, which is original, is almost identical in dimensions to the southern statue. The two statues originally, we believe, were identical in size. The height of the intact southern statue was determined by us to be 14.30 m. The base of the statues, where they rest on their pedestals, is 10.50 m from front to back and 5.43 m in width.

The massive pedestals lie 17.7 m apart with their long axes (east to west) within 1° of being parallel on a magnetic azimuth of 120°. Neither of the pedestals is a single block; each pedestal consists of a very large front block and a series of smaller ones in the rear. An alluvial fill some 2 m deep has accumulated around the pedestals since they were first set in place. We were not permitted to excavate a trench to take another measurement of the height of the pedestals, and to determine the type of foundation on which they rest, because recent digging of an irrigation canal 30 m to the south had aroused fear for the stability of the statues, and because of the apprehension that even a small excavation might aggravate the existing inclination from the vertical of the southern statue. We would have liked to settle once and for all the nature of the foundation on which the pedestals stand. Wilkinson said the pedestals rest on constructions of sandstone placed over sandy soil (*9*). Jollois and DeVilliers also state that the pedestals stand on thick sandstone blocks (*11*, p. 161). Catherwood found that "they reposed only on a stratum of sand" (*12*), while Wiedemann described them as standing on heterogeneous ground, capable of softening (*13*).

Actually, Jollois and DeVilliers observed the inclination of the statues as early as the beginning of the 19th century (*11*, pp. 157 and 161). Their description indicates that the north face of the pedestal of the south colossus was inclined 1°30′ to the north. In 1971 we measured the inclination and found it to be 1°22′ to the west and 1°22′ to the north. Apparently there has been no significant change in the last 170 years. The same appears to hold true for the even greater inclination of the northern statue (2°39′ to the south), which may have existed even in antiquity, according to Jollois.

The weight of the statues has been calculated by a number of earlier students. Jollois and DeVilliers (*11*, p. 159) determined the weight of the southern statue to be 749,899 kilograms. Barber (*7*) says the weight is between 800 and 1000 tons; Petrie (*14*) estimates the statues each at 1175 metric tons. Jollois and DeVilliers calculated the volume to be 292 m^3. Our measurements yield a figure of 271 m^3 for the volume of the southern statue; if we apply the present-day handbook value of 2.65 for the density of quartzite (*15*), we obtain a weight of 720 metric tons (*16*).

Transport of the Statues

No contemporary record exists which tells us how the two 720-ton sculptures were brought from the quarry to Thebes nor in what state of completion they were when they were moved. The statues must have either been loaded on heavy sledges and dragged on land, or placed on a barge and towed on the river. River transport for such a long distance was almost certainly the means by which the two great statues were moved. Queen Hatshepsut's temple at Deir el Bahri, about 2 km northwest of the colossi, has a low-relief carving showing two obelisks, weighing together 700 tons, attached to dragging-sledges, and lying base to base on the deck of a big lighter. Opinions vary as to the interpretation of this scene, some students holding that it is not a literal depiction but in part an artistic convention because they believe the obelisks were carried singly and not as a pair. Ballard (*17*) thinks the lighter was 207 feet long and 69 feet wide with a hull weight of 600 tons and, when loaded with one obelisk weighing 370 tons, had a draft of 8 feet (1 foot equals 0.3 m). Sølver (*18*) believes the lighter was 207 feet long, 82 feet wide, and was loaded with the two obelisks together weighing 700 tons lying side by side. The Deir el Bahri reliefs show the obelisk lighter being towed on the Nile by three parallel lines of nine towing barges to a line. Each barge held 32 oarsmen, the total being 864 (*17, 18*). Hatshepsut's obelisk lighter, which was made about a century before Amenhotep's colossi were transported, was perhaps a large enough craft to have carried one of the statues. But the statues were, as we shall see, brought upstream and against the current, and the lighter would have required more or larger towing barges and oarsmen. Probably long towing ropes extending to shore allowed gangs of men on the bank to help keep the lighter moving. Such upstream towing of feluccas is done today on the Nile when the wind fails. If the lighter carrying the statue and weighing about 1500 tons was towed both by barge and by men on the bank, the number of men involved as draggers and oarsmen may have numbered around 1800 (*19*).

To move the 720-ton statue from the quarry to the Nile bank by lashing it to a sledge and running it over friction-reducing sleepers may have required the energy of about 3600 men, according to the formula of Sølver (*18*). Barber (*7*, p. 17) calculated that about 15,000 men would have been needed. The statue, still attached to the sledge which was to be used later, was then put on the lighter. When the statue arrived at Thebes, it had to be unshipped and dragged to the spot where the pedestals were already set in place. A great artificial lake, now drained and under cultivation, is believed to have been constructed during the reign of Amenhotep III, and certainly was used by him and his retinue. This lake area, now known as Birket Habu, is delineated by ancient embankments except for the side facing southeast, which is generally thought to have been open to the Nile via a short, wide canal. The northeastern corner of the lake site of Birket Habu is only about 0.8 km away from the colossi, and this waterway thus suggests itself as a convenient approach for the colossi and also for the delivery of many other objects and building materials required during the construction of the mortuary temple, of which the colossi were a part. Thus we made a subsurface search with augers for a postulated docking area near the northeastern corner of this lake site, at a point on the lake edge where there was a break in the embankment and which was in line with the two pedestals. Since it has long been known that both statues were brought in from the south (*20*), a long, inclined ramp built of mud or sun-dried brick must have run off south of the statues. To raise the statues, which were loaded on their sides, to a sufficient height to enable them to be lowered to the pedestals would require a ramp of from 700 to 900 feet long, with a grade of about 1 : 17. We found what we think may have been such a docking area in the form of a narrow extension to the north of the lake, now sand-filled in the lower level and capped with 2 m of Nile overflow silts. However, we are not certain of this identification—all we can say is that we located a possible dock area, situated where we believe the statues were taken off the lighters after having been brought into Birket Habu from the Nile by a canal. After being unloaded, the statues were drawn up the ramp and lowered into place onto their pedestals, the northern statue first and the southern one last.

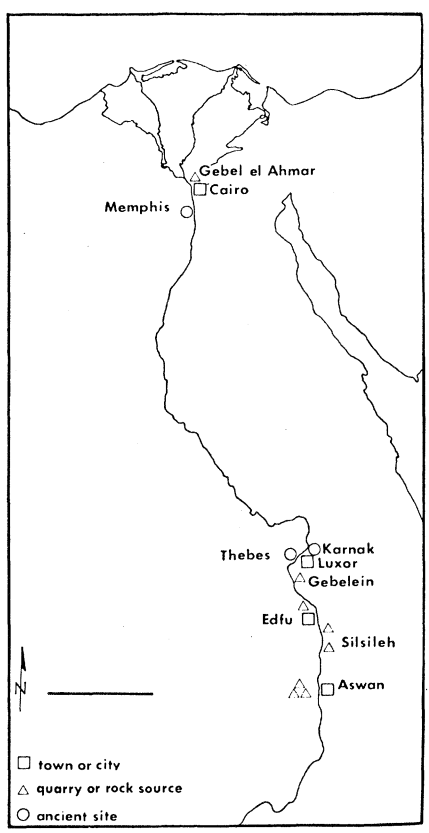


Fig. 1. Locations of ancient quartzite deposits and archeological sites relating to our investigation of the Colossi of Memnon.

Source of the Stone

Each of the colossi originally was a monolithic piece of rock, and each rested on a pedestal of similar material. The pedestals are in the form of rectangular parallelepipeds and are now broken in several places, but some contiguous surfaces are dressed and represent evidence that the pedestals were not monolithic.

The material from which the sculptures were carved has long been recognized to be quartzose sandstone, or "quartzite" (*21*). The genesis of this rock does not seem to be fully understood, and is of interest to us only because of its connection with the marked heterogeneity of composition shown by the rock from which the colossi are made. Some samples picked up at one of the quarries we studied seem to be nearly pure iron oxide, while other samples collected close by are essentially quartz. This heterogeneity is a major source of difficulty in the attempt to relate the sculptures to their quarries by analytical means.

According to Lucas and Harris (*23*), quartzite occurs at Gebel el Ahmar, several kilometers northeast of Cairo-Heliopolis; between Cairo and Suez; on the Bir Hammam Moghara road at Gart Muluk in the Wadi Natrun depression, both in the western desert; on the east side of the Nile near Aswan; and in the Sinai. In addition to these sources, quartzite reportedly also was quarried at Gebelein (*24*), at Silsileh (*25*), and just south of Edfu (*26*); there apparently also are traces of ancient quartzite quarrying activities between Edfu and Aswan (*27*) (see Fig. 1).

We shall not consider quarries without reasonable access to the Nile, since transportation of such great weights over hilly terrain or over considerable distances overland is highly unlikely. This eliminates the deposit on the road between Cairo and Suez and the Sinai and Wadi Natrun sources.

The literature on the presumed provenience of the stone for the statues is summarized by Varille (*28*). Conclusions regarding the source of the stone in the past have been reached mainly on epigraphic evidence—that is, on the basis of ancient inscriptions on the colossi or other sculptures or in the quarries themselves.

The inscriptions relating the colossi most directly to their sources are probably those found on the back of the southern colossus, on the lap of a seated statue (now in the Cairo Museum) of Amenhotep, son of Hapu, namesake and Overseer of Works of Amenhotep III, and in the quarries of Aswan. While the first two refer to the transportation of great monuments from Heliopolis-of-the-North (Gebel el Ahmar) to Heliopolis-of-the-South (identified by Varille with Qasr el Agouz, about 1 km from the colossi) the inscriptions do not specifically refer to the colossi under discussion.

Steindorff believes the source of the quartzite to have been the quarries "above Edfu" (*26*). Daressy intimates that the source is Gebelein (*24*). Varille thinks that the quartzite came from Gebel el Ahmar (*29*). Habachi (*30*) has made a persuasive case for the source being three contiguous quartzite quarries located at Aswan across the river from the famous granite quarries. The Aswan inscriptions, still to be seen on the rock, show Bak, chief sculptor of Amenhotep IV (Akhnaton) and Men, father of Bak, who had a corresponding position at the court of Akhnaton's father, Amenhotep III. The inscriptions identify Men as "Overseer of Works in the Red Mountain, Chief of the Sculptors of the great and mighty monuments of the King," and also depicts a colossal statue made from the local stone, which very strongly suggests that it represents the colossi that are the subject of our study.

Harris (*22*) states that before the reign of Amenhotep III, quartzite seems to have been called *inr n rwdt nt dsr* (*31*), designating it as a species of sandstone (*inr n rwdt*). Subsequently, the most common term for quartzite is *bi't*, which is thought to mean literally "stone of wonder," and Sethe (*32*) suggests that the notion of wonder may actually have arisen with the Colossi of Memnon themselves.

As one goes south from Thebes, the sandstone near the Nile assumes a siliceous character some distance south of Gebelein, which is located about 30 km south of Thebes. This corresponds to the rock that frequently has been called quartzite, Nubian sandstone, quartzose sandstone, and gritstone, although this nomenclature does not necessarily coincide with the more rigorous terminology and characterization of petrographers and geologists. The sandstone, or the quartzite, exposed at the deposits south of Thebes, is of quite different geological age than that of Gebel el Ahmar near Cairo. This may be reflected in differences in chemical composition.

Table 1. Quartzite samples that were analyzed by neutron activation of radionuclides.

Source of samples	General area	Number of samples	Approximate distance from the Colossi of Memnon (km)
	Quarry samples		
Gebel el Ahmar	Cairo	22	676 North
9 km north of Edfu	Edfu	1	97 South
8 km north of Edfu	Edfu	1	98 South
8 km south of Edfu	Edfu	4	114 South
Silsileh	Silsileh	1	148 South
Gebel Osman	Aswan	14	214 South
Osman Valley	Aswan	9	214 South
Gebel Simeon	Aswan	11	214 South
	Artifact samples		
Statue of Ramses II at Memphis	Cairo	1	650 North
North statue of Memnon	Thebes	13	
Reconstructed portion	Thebes	3	
Pedestal, loose block	Thebes	1	
South statue of Memnon	Thebes	8	
Pedestal, main block	Thebes	3	
Ruined colossus west of Memnon statues	Thebes	1	
Sculpture from mortuary temple of Amenhotep III	Thebes	1	
Great stela near mortuary temple of Amenhotep III	Thebes	3	
South statue in front of tenth pylon at Karnak	Karnak	5	
Pedestal of north statue in front of tenth pylon at Karnak	Karnak	1	
Sarcophagus of Thoutmoses IV, Valley of the Kings	Thebes	1	

The provenience of some types of artifacts can be determined by correlating their chemical composition with that of samples from geologic sources. Successful results have been obtained with materials ranging from obsidian to ceramics. It therefore seemed appropriate for us to use such a technique in our study of the colossi.

The chemical composition of samples of quartzite rock from the colossi and from various quarries was determined by neutron activation analysis. In addition, petrographic studies were made of some of the samples analyzed by neutron activation. These studies were conducted independently in different laboratories.

Neutron Activation Analysis of the Rock Samples

The provenience of artifacts is most easily determined without undue difficulty by determining their composition patterns when the artifacts in a particular area form a chemically homogeneous group, or when some of the elements they contain show a high degree of coherence (*33*). When chemical compositions vary greatly within single monoliths, as they do in the Colossi of Memnon, and also vary greatly among the samples of quartzite from a single quarry, the determination of provenience is more difficult.

Ideally, a certain number of elements would have distinctive abundances for each quarry of possible interest. Then, the amounts of these elements in a statue would match the samples from one of these quarries and none of the others. If several samples from a single quarry were chemically nonuniform, it might be impossible to find any element with the same abundance in each sample. It might still be possible to make meaningful provenience deductions, however. Let us suppose that the analysis of several samples from a statue produced a range of abundances of certain elements that matched the range of abundances of these elements in samples from a particular quarry. Even with some overlap among several quarries the pattern-fitting could be distinctive. Furthermore, this would indicate that the nonuniformity in the statue might be reflected throughout the quarry with which it has been matched. If the composition of the statue varied less than the quarry as a whole, one might be able to find from which particular part of the quarry it came by finding localized quarry samples which showed this smaller range of abundances.

The situation is certainly not ideal in the present instance. We have analyzed over 110 samples from seven quarries and nine sculptures (see Table 1). Twenty-three quarry samples were from the Cairo area and 37 from three quarry locations near Aswan. These samples were selected by a geologist and their origin is certain. A few samples were also available from quarries between Luxor and Aswan, but their precise geographical location is less certain and their numbers are too small to give a good perspective of the variations in chemical composition that are possible in these quarries. The sampling was perforce limited, and was particularly difficult because the quarries were inaccessible for military reasons and the samples had to be collected by intermediaries.

On the basis of the samples analyzed we can show that the Gebel el Ahmar quarry some 676 km downstream on the Nile is far more likely to be the source of the Colossi of Memnon than the quarries at Aswan which are upstream at a distance of only about 200 km.

The abundances of some elements are measured by neutron activation analysis, in many cases approaching a precision of about 1 percent (*34*). Many of these elements are present in the part-per-million range. In our studies, the quartzite samples were broken open and approximately 2 grams of chips from the center were crushed to a powder with a ceramic mortar and pestle. Powder samples of 100 milligrams were pressed into pills, cellulose being used as a binder. They were then irradiated, along with pottery standards of known composition, in the research reactor at the University of California. When the abundances of the gamma rays emitted by the samples were compared with those of the standards, we obtained the absolute abundances of the various elements in the samples.

Except at the location 8 km south of Edfu, the amounts of aluminum, magnesium, calcium, and titanium found in the quarry samples were below 1 percent; sodium and potassium were found in amounts below 0.18 percent; the amount of iron was highly variable. The major constituent, silica, was not measured.

The only quarries that, by virtue of the quality of their rock, their size, and documented tradition (graffiti or other records), are at all likely to have furnished the raw material for the colossi, are Gebel el Ahmar (Cairo), Silsileh, and the three contiguous Aswan quarries.

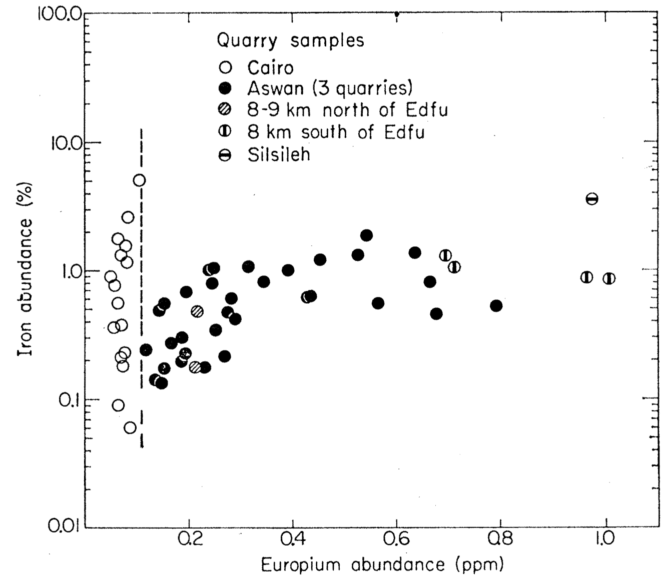


Fig. 2. Abundance of iron compared with europium in the quarry samples. The dashed line separating the quarry samples is somewhat arbitrarily placed at 0.11 part of europium per million.

Although it is unlikely that the stone for the colossi came from deposits other than those already mentioned, we also analyzed several samples collected for us by an official of the Egyptian Department of Antiquities. Those samples came from several less important outcrops 8 and 9 km north of Edfu and 8 km south of Edfu.

The quarry 8 km south of Edfu. Our four samples from this deposit are distinctive in their chemical composition and are comparatively homogeneous. For example, the amounts of manganese (about 0.4 percent) and calcium (15 percent) they contain are a factor of 10 higher than in any other samples. Samples from the Colossi of Memnon and the other quarries are certainly not related to this material. More samples of this deposit should be obtained, however, to see if these distinctions are pervasive.

The deposits 8 and 9 km north of Edfu. We have only one sample from each location and these cannot be distinguished from the samples from quarries in the Aswan area. Again, a wider sampling of the deposits might permit such a differentiation.

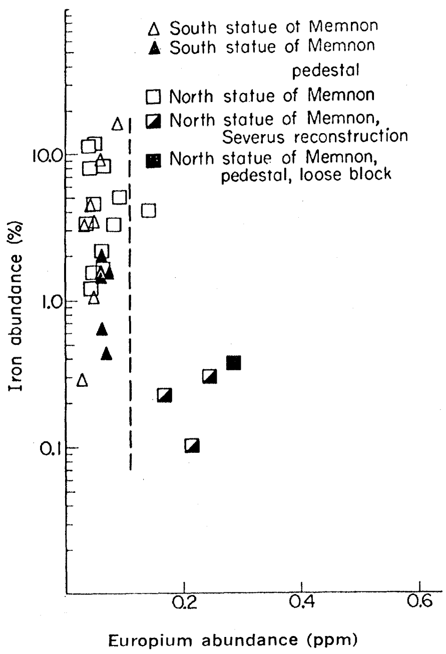
Silsileh. Only one sample could be obtained from Silsileh. It is very distinctive in its composition, the barium content, for example, being 1 percent, that is, over one order of magnitude higher than the barium content of any of the other samples. This sample is not like any of the statue samples, but its composition most closely resembles that of the samples from 8 km south of Edfu. Here, too, more samples should be obtained.

Aswan quarries (Gebel Osman, Osman Valley, Gebel Simeon). Thirty-four samples were analyzed from these three quarries. Although further sampling might permit us to distinguish between them, such sampling is not possible now because of military security regulations.

Cairo quarry (Gebel el Ahmar). Twenty-two samples from the Cairo quarry were measured. Samples from all the quarries mentioned above can be distinguished from the Cairo samples by the abundances of the light rare earth elements, especially europium. Figure 2 shows that the Cairo samples have Eu abundances of 0.05 to 0.1 part per million (ppm) while the other quarries have Eu values of 0.1 to 1.0 ppm.

Colossi of Memnon. Figure 3 shows the Eu content of the samples from the Colossi of Memnon, their pedestals, and the reconstructed portion of the north colossus. In general, the Eu abundances were below 0.1 ppm which is consistent with the Cairo quarry but with none of the others sampled. The samples from the reconstructed upper portion of the north colossus and a loose block at the rear of the pedestal match more closely the samples from Aswan and from the quarries 8 and 9 km north of Edfu.

Rock samples from the colossi con-



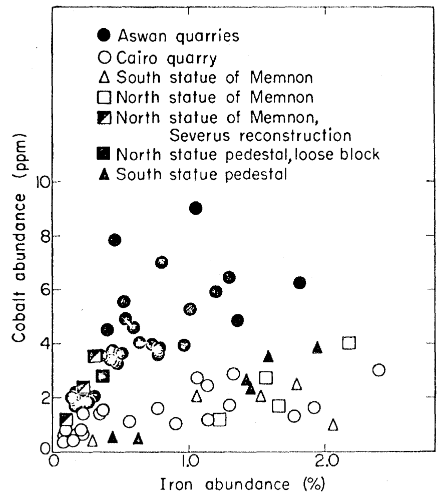


Fig. 3 (left). Abundance of iron compared with europium in the colossi samples. The dashed line is placed at 0.11 part of europium per million as in Fig. 2. Fig. 4 (right). Abundance of cobalt compared with iron in the colossi samples and in the Aswan and Cairo quarry samples.

tain up to 15 percent iron, much more than any of the quarry samples. Among the quarry samples, those from Gebel el Ahmar contain the most iron. This may simply mean that if the colossi came from Gebel el Ahmar they came from an area or from material which we have not sampled. In this respect, a quartzite statue of Ramses II found at Memphis near Cairo and presumed to have come from Gebel el Ahmar had a high Fe abundance (4 percent) as well as a Eu content below 0.1 ppm.

Because of the coherence between the abundance of Fe and some other elements in our samples from Gebel el Ahmar and the Aswan quarries, we decided to study further only those samples of low Fe content in a range common to both quarry areas and the colossi. Figure 4 shows that the Gebel el Ahmar and Aswan samples have distinctively different patterns of cobalt abundance when this is compared with the abundance of Fe. Samples from the pedestal of the south colossus resemble those from Cairo more than those from Aswan. The patterns of Co and Fe abundance in the samples from the quarries 8 and 9 km north of Edfu resemble those from Aswan, while samples from the quarry 8 km south of Edfu resemble those from Gebel el Ahmar.

The samples from the reconstructed portion of the north colossus do not match the Gebel el Ahmar pattern but are consistent with the quarry samples both from Aswan and from 8 and 9 km north of Edfu. Samples from a loose block on the north colossus pedestal are also consistent with the Aswan and Edfu samples.

Petrographic Analysis of Thin Sections

Petrographic studies were made of thin sections from 12 samples taken from five quarries and 6 samples from the colossi. Of the quarry samples, five were from Gebel el Ahmar, four from the Aswan quarries, one from Silsileh, one from the quarry 8 km south of Edfu, and one from the quarry 8 km north of Edfu. Of the six colossi samples, one was from a reconstruction block.

The five main colossi samples consist of quartzose sandstone and closely resemble the samples from Gebel el Ahmar. They are medium to coarse grained, with grains commonly as much as 2 millimeters in diameter. Most grains are of quartz; quartzite is rare to common. Chert occurs in three sections, metachert in two, and a feathery-textured unidentified mineral together with tourmaline occurs in one section. The presence of two grains of chalcedonic quartz in one of these five colossi samples is the only feature not common to the Gebel el Ahmar sandstones. No significant petrographic difference between these five statue samples and the samples from Gebel el Ahmar could be found. The one sample taken from a reconstruction block of the north statue is microscopically indistinguishable from a sandstone sample obtained from 8 km north of Edfu. It resembles no other quarry samples.

Conclusions

The only areas that are likely to have furnished the original stone for the Colossi of Memnon are near Cairo (Gebel el Ahmar), Aswan, and possibly Silsileh. Neutron activation analysis of samples from the colossi shows them to be distinctly different from samples obtained from the three known quarries near Aswan and from the quarries near Silsileh and Edfu, but very similar to samples obtained from Gebel el Ahmar. Petrographic analysis of colossi and quarry samples also provides strong evidence that the colossi came from Gebel el Ahmar.

The blocks used by the engineers of Septimius Severus to reconstruct the north colossus were shown by neutron activation analysis to have originated from a deposit other than Gebel el Ahmar. The composition of these blocks conformed with samples taken from the quarries 8 and 9 km north of Edfu (the quartzite deposit closest to Thebes) and from the Aswan quarries. Petrographic analysis associated these reconstruction blocks with Edfu but not with Aswan.

Neutron activation analysis of other artifacts in the area of the colossi indicates that they also came from Cairo rather than Aswan.

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29. ———, *ibid.*, pp. 91–93. On p. 93, Varille states: "Thus, in spite of the verdict of the geologists, there can be no doubt about the site of the 'Mountain of sandstone,' where the colossi of Memnon were cut out." The geologists of the early part of this century indeed could not match the "pebbly" nature of the quartzite of the colossi with that of Gebel el Ahmar, but Lucas and Harris (*23*) confirm the occurrence of quartzite containing such inclusions in some parts of Gebel el Ahmar. We have samples with such pebble inclusions from this quarry.
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35. For the petrographic studies we are greatly indebted to Prof. Richard Hay of the Department of Geology and Geophysics, University of California, Berkeley. Field research for the 1971 and 1972 expeditions was supported by the National Geographic Society's Committee on Research. Travel funds for A.A. and T.R.H. came from a Ford Foundation grant for graduate student traineeships in archeology. We thank the following persons for their help with our project: Dr. Zaki Iskander, director general of the Service des Antiquités, Egypt; Drs. Salah Osman, Mahmoud Abdelrazik, Henri Riad, Ahmed el Taher, Abdel Kader Selim, Labib Habashi, Rigaaie Zaki, and the late Gamal Mehrez, all of the Service; Dr. Ahmed Talaat, Egyptian Museum of Geology; Drs. Herbert Ricke and Gerhard Haeny, Swiss Institute for Research in Ancient Egyptian Architecture and Archaeology; and Ahmed Hassan Younes, who in Cairo and at Luxor acted as our intermediary. The nuclear measurements and their interpretation were performed under the auspices of the U.S. Atomic Energy Commission.

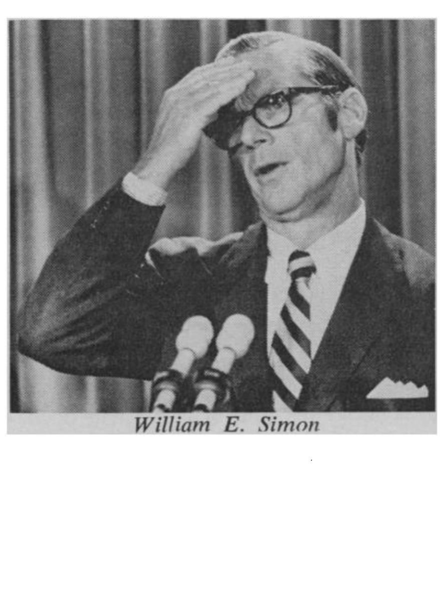
NEWS AND COMMENT

Energy Organization: Love's Labour's Lost

Furniture movers and telephone installers were hard at work on the fourth floor of Washington's New Executive Office Building last week, setting up a comfortable new nest near the White House for the third energy policy czardom the nation has seen this year.

First came John D. Ehrlichman, the President's deposed adviser on domestic affairs, who established himself as the head of an energy triumvirate in January. That arrangement collapsed in the spring as Ehrlichman departed under the Watergate cloud. Next came John Love, who traded the security of the Colorado governorship for what turned out to be a small and rather powerless portfolio as head of the White House Energy Policy Office. In place of the EPO and Governor Love, President Nixon announced on 4 December that he was establishing by Executive order a new Federal Energy Office (FEO) to pull the nation through what promises to be a winter of severe discontent.

The new organization has a certain inner logic to it, although its legal status and its future remain somewhat cloudy. As described in a fact sheet handed out by the White House, the FEO consolidates a number of disparate but related elements of the Interior Department, the Office of Management and Budget, and the Cost of Living Council. In the process, the FEO extends and formalizes the already considerable authority over energy policy—particularly fuel allocation—accumulated in recent months by William E. Simon, deputy Treasury secretary (and the FEO's new director) and John C. Sawhill, the OMB's man in charge of energy and natural resource budgets (now Simon's deputy).


William E. Simon

Until Congress approves the reorganization, however, Simon and Sawhill can't legally exercise authority over the 1300 employees and $31 million in energy programs inherited from the Interior Department. The Interior Department is being asked to cooperate voluntarily with the FEO until Congress sanctions the marriage and changes its name from Office to Administration, but Interior Secretary Rogers C. B. Morton is rumored to be less than happy with this arrangement.

At the least, the FEA proposal adds a new kink to an already confusing sequence of messages to Congress on federal reorganization. Last June, President Nixon tossed out an earlier set of proposed organization plans for energy and natural resources, and called on Congress instead to set up three new agencies: a Department of Energy and Natural Resources, an Energy Research and Development Administration, and a Nuclear Energy Commission (*Science*, 13 July).

Then on 7 November, Nixon asked Congress to put off consideration of the DENR until next year and to concentrate instead on approving the new R & D agency. Now the White House has, in effect, partially negated the latter request. For the FEO turns out to be the "energy" part of the DENR and