SCIENTIFIC TESTING AT GLOZEL

by Alice and Robert Gerard and Hugh McKerrell

Overview

During the last 75 years scientists have used a number of different methods to add to our understanding of the artifacts from the site of Glozel. The first tests, chemical analyses performed in the 1920s, were used to gather information about the composition of glass and pottery and the age of bone. The findings of the early glass and pottery analyses have been confirmed and expanded by more recent tests made in the 1990s.The early chemical analyses made on bones gave only an approximate idea of their age, but it was clear that they were not modern. In the 1950s Dr. Morlet attempted to have several bones dated by Carbon-14, then still in its infancy and not yet giving reliable results. In the 1970s the Swedish physicist Vagn Mejdahl began to use the new technique of thermoluminescence to measure the age of Glozel ceramics; the Scottish chemist Hugh McKerrell and the French physicist Henri François later joined him in his investigations. They also obtained two C-14 dates, one no longer considered valid because of contamination. Their results placed Glozel in the Celtic period, between 300 B.C. and 300 A.D.

More TL tests and three C-14 tests were made as part of the research undertaken in 1983 by the French Minister of Culture. A number of these results were either medieval or modern. In 1995 two bone tubes from one of the tombs were dated by C-14; both turned out to date to the 13th century A.D. Further C-14 tests since then have also yielded medieval dates, and even some 17th century dates.

Our ability to use more and better scientific tests has not yet helped us to solve the enigma of Glozel. Magnetic measurements by John Shaw at Liverpool University have helped to explain some of these anomalous TL dates.

The Chemical Analysis of Glass

Glozel glass was first analyzed in the 1920s by Professor Croze, using spectrographic techniques and classic wet chemistry, and by M. Bruet, Vice President of the Geological Society of France. It was analyzed again in the 1990s at the Slowpoke Reactor at Toronto University in Canada by the technique of neutron activation analysis. The new and old analyses are in general agreement. The most recent tests identified seven types of glass, three of them high-potassium glass typical of the French medieval period. High potassium is a characteristic of medieval glass made with local plant ash instead of imported alkali, which produces glass high in sodium. The three high-potassium glasses could all have been produced at Glozel, using local bracken and sand from the Vareille. Three other glasses had a mixture of sodium and potassium; their origin could not be determined. One extremely unusual high-arsenic, high-sodium glass could not have been produced at Glozel and may have been imported from the Near East.

Analyses Made on Glozel Ceramics

I. The Chemical Analysis of Pottery

In 1928 Bruet performed an examination of a Glozel tablet with inscriptions using a microscope with polarizing light to identify the consituents of the clay. He also examined a sample of the raw Glozel clay. He found that the same proportions of the same minerals were present in both samples, allowing one to conclude that the tablet was made from Glozel clay. Bruet also observed that in the tablet the colloidal structure of the clay had been altered by a firing to at least 600° C.

Archaeomagnetic studies by Barbetti in 1976 showed that the objects could not have been made of reconsituted older ceramic ware, and again showed that five out of six were fired to at least 500° C. Also in 1976 Zimmerman applied the zircon dating technique to two objects and found that there was no possibililty that they had been artificially irradiated to "age" them.

Tests using differential thermal analysis on fourteen Glozel ceramic artifacts were performed by Vagn Mejdahl in 1980; they established that ten of the fourteen had been fired to at least 500° C.

The recent neutron activation analysis in Toronto of a phallic idol and five inscribed tablets confirms that the objects were made from Glozel clay. Stoneware pottery samples, however, clearly were made somewhere else. This stoneware was used to make the crucibles which composed part of the glassmaking debris from the Field of the Dead.

II. The Dating of Ceramics by Thermoluminescence (TL)

The thermoluminescence study of ceramics from Glozel is almost as old as TL dating itself. In December 1971, Mme. Greta Ringström, a friend of Dr Harry Söderman, asked Vagn Mejdahl of the Danish Atomic Energy Authority if he could TL date a ceramic piece from Glozel. He said he could and Mme. Ringström arranged for a regular visitor to Glozel, a fellow Swede, Sture Silow, to bring back to Denmark a ceramic tablet inscribed with alphabetic signs. Mejdahl showed that about 2500 years had passed since the tablet was fired and he presented his result in March 1973 to an archaeology and science conference in Great Britain.

After the British chemist Hugh McKerrell heard Mejdahl's presentation, he went back to his laboratory at the National Museum of Antiquities in Edinburgh and set to work to date a tablet fragment from Glozel which had been sitting neglected on a shelf. The fragment had been taken from Glozel by Glyn Daniel and no one had though it worthwhile dating. TL testing determined that it had probably been made in the early second century AD. Intrigued, McKerrell joined Mejdahl in his program to date more Glozel ceramics.

The first extensive TL work, carried out in 1974, was an authenticity survey of nineteen ceramic artifacts from Glozel. By then two French colleagues, Henri François and Guy Portal, had joined the Scottish and Danish team and their joint first paper, authenticating the Glozel ceramics, appeared in the journal *Antiquity* in 1974 (McKerrell et al 1974).

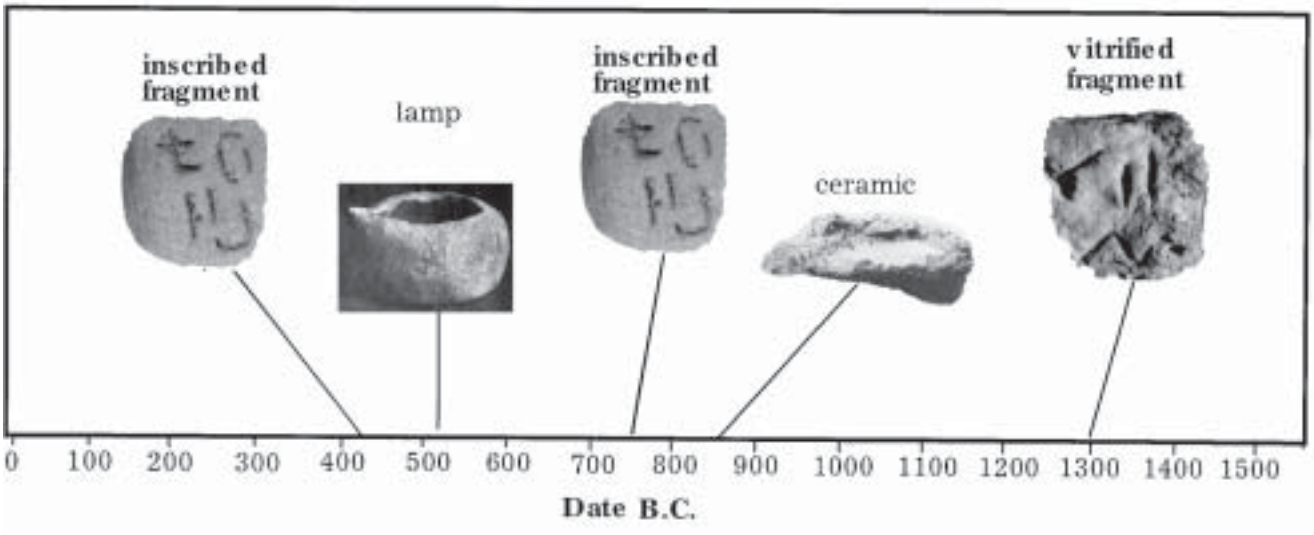
By 1979 the group had carried out 39 TL datings on 27 artifacts. The dates fell largely into three groups: an early period from about 300 B.C. to 300 A.D.; a medieval period that clustered around the 13th century; and a recent period. Fifteen of the artifacts dated to the early period. These consisted of inscribed tablets, lamps, face urns, vases, and an enigmatic object that Morlet called a bobine.

Eight pieces dated to the medieval period. Four of these were associated with the medieval glassmaking industry: two pieces of mortar from the fosse ovale; a piece of vitrified clay; and a large brick from the floor of the fosse. The other four had all been collected from the area of the fosse ovale; they consisted of a tablet, a phallic symbol, a hand imprint and a face urn. The hand imprint may actually be medieval. Hand prints were found in the fosse ovale, and none have been dated to the earlier period. But the other three are hard to understand as medieval artifacts. Barbetti's archaeomagnetic investigation found that this same tablet had been heated twice, the first time to above 500° C. and the second time to a lower temperature. It seems reasonable to conclude that the original Celtic TL dates of these three objects may have been reset to the middle ages because of exposure to the heat of the fosse ovale, which can reset the TL clock to zero. A lump of clay and a brick with cupules dated to the late 18th century, and a vitrified tablet dated to the 20th century.

In 1983, as part of the new investigation of Glozel by the Minister of Culture, tests were performed at the Oxford TL laboratory on five ceramic samples, again excavated close to the remains of the fosse ovale. The range of dates — from the mid fourth century to the medieval period — can only be explained by resetting of the TL clock of these artifacts. Otherwise one would have to assume the survival of a Celtic language at Glozel until the early middle ages. In 1985 scientists from Oxford dated five ceramics from the museum. Two vitrified tablets were recent in date; the other three inscribed fragments were medieval.

Table I

The 1983 TL dates from Oxford, made on pieces found near the Fosse Ovale



Eight of the artifacts TL-dated by Risö or Edinburgh were also dated at Oxford. In three cases there was good agreement between the laboratories, and in one case a fair agreement. In two cases, both inscribed tablets, Risö dated the object as about 2000 years old and Oxford placed it in the medieval period. One of these pieces was found close to the fosse ovale and may have been altered by reheating. The other was the first tablet dated by TL and there is no information about its provenance. Since the laboratories took samples from different areas of the tablets, their disagreement may have occurred because one side of a tablet had a more recent date, being closer to the fosse ovale, than the other side of the tablet, not exposed to enough heat to reset the date. In the last two cases, a piece of clay and a brick with cupules were dated to the 18th century at Risö and to the 1920s at Oxford.

The recently dated ceramic artifacts found at Glozel, shown in Table 4, have aroused deep suspicion. In 1998 McKerrell removed a lump of what he thought was charcoal from the surface of a vitrified tablet, 984.2.006, and sent it to Arizona for C-14 dating.It turned out to be more than 46,000 years old, meaning that it was either coal

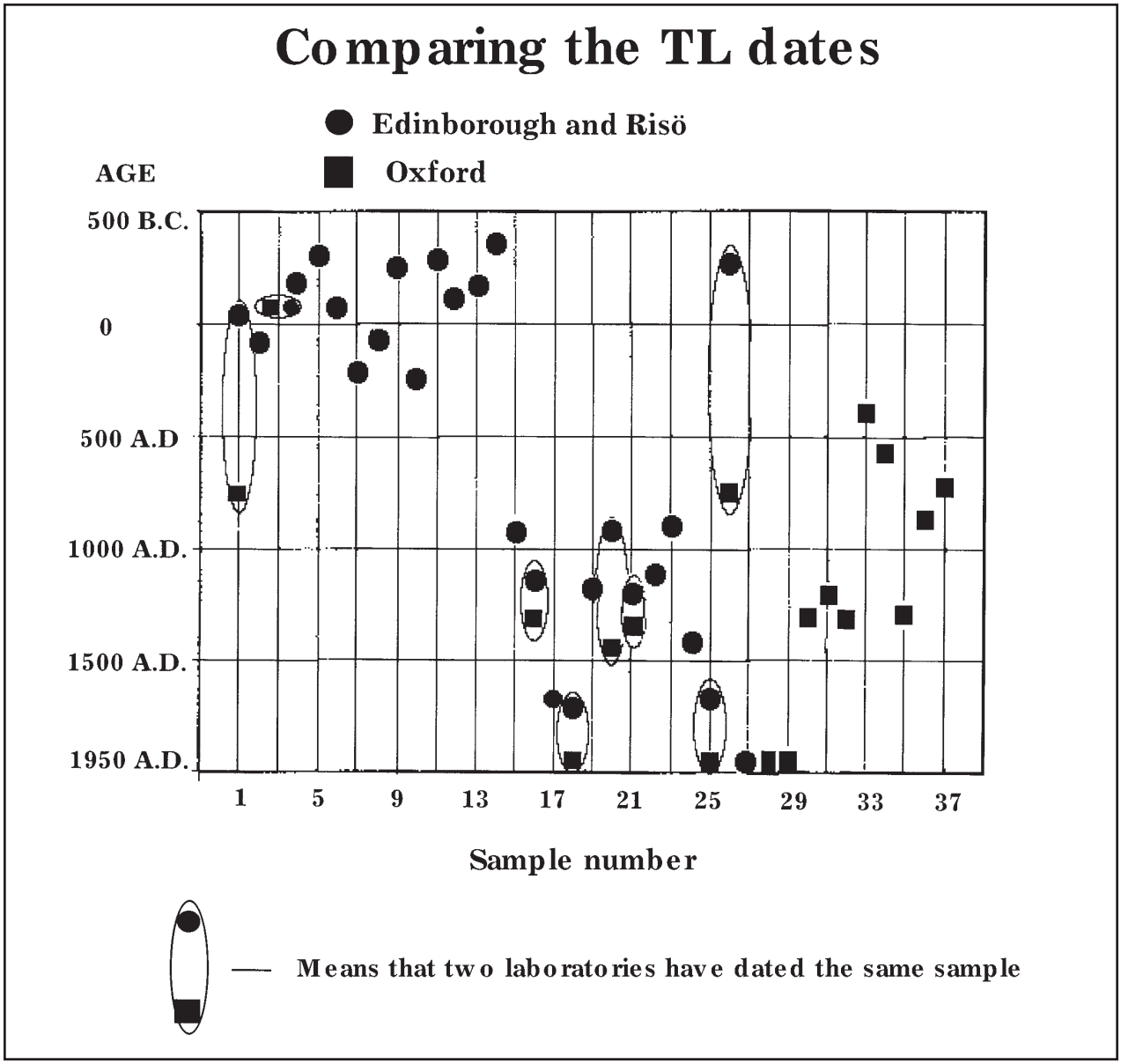


Table 2

The Recent Thermoluminescence Dates E/Edinburgh O/Oxford R/Riso

Lab Ref.	Mus. No.	Age BP 1950=0	TL Technique	Photograph	Object
17. E/764002	Non	1750 A.D.	quartz inclusions	no	vitrified tablet
18. R/794001	GF8	1770 A.D.± 100	quartz inclusions	yes	clay
O/1 98.f1	GF8	1930 A.D.± 20	fine grains	yes	clay
25. R/794009	GF1164	1720 A.D.±100	quartz inclusions	yes	brick with cupules
O/198.f8	GFI 164	1927 A.D.± 12	fine grains	yes	brick with cupules
27. E/756001	GF1637	1920A.D.± 15	quartz inclusions	yes	vitrified tablet
28. O/198.dl	984.2.006	1910 A.D.± 18	fine grains	no	vitrified tablet
29. O/198.d2	984.2.022	1920 A.D.± 14	fine grains	no	vitrified tablet

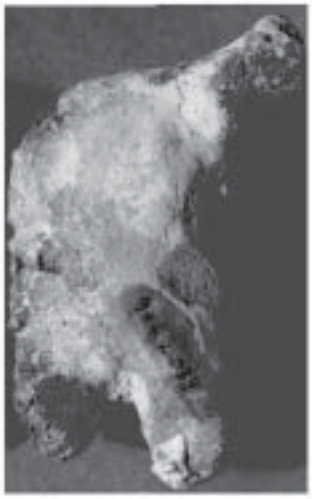
or coke. Since we have no knowledge that medieval glassmakers used coal, he began to wonder if it had been reheated recently. When he found coke on the surface of another tablet, GF1637, he became certain that the two pieces had been reheated recently in a modern forge. It was hard to understand why this should be done.

However, one can see from the photographs of these tablets in Morlet's *Glozel* that 984.2.006 was attached to a phallic idol when found and GF1637 had a piece of clay stuck to one edge. Today the idol is separated from the first tablet and the piece of clay is gone from the edge of the second. The interior of both tablets has the grey color that results from a reduction firing like that in a glassmaker's kiln but unlike that from a modern forge. The glass samples found on both tablets differ from those on modern glass, and the phallic idol actually has five different layers of glass on it, meaning that it was in a kiln for five firings. The best explanation for these recently-dated pieces is that they were already vitrified when found and that Morlet heated them in a forge to separate the attached objects, both of which were obscuring letters on the tablets below.

There is a different explanation for the remaining four pieces: a lump of clay; a brick with cupules; and two vitrified tablets. None of them have letters covered by glass and there would be no reason to heat them in a forge, even if fraudulence was the explanation. Instead, a field firing may explain the modern dates on these pieces. At some time between 1885 and 1900 the Champs des Morts was deforested after many years of disuse. The remains of large tree roots and a quantity of charcoal, which would result from such a fire, were actually found in the field. Ordinarily much of the wood from the trees that were cut down would have been transported to the farm to use as firewood, but the steepness of the hill makes this unlikely. Significant conflagrations were capable of vitrifiying material in Iron Age hill forts. A major burning of trees and brush in 1890 at Glozel, one that also brought buried material nearer the surface when large trees were uprooted, should certainly have been capable of reheating some of the ceramic pieces so that they dated to recent times.

Figure 3

Tablette vitrifée 982.2.006 et idole phallique quand trouvés



Idole seule, aujourd'hui

Tablette seule, aujourd'hui

GF1637, quand trouvé

Neither explanation for the recent pieces solves the problem arising from the fact that Oxford and Risö obtained different TL dates on some of these same pieces. One possibility is, as suggested above, that the two laboratories were testing different places on the tablets. The topside of a buried artifact exposed to a major field fire would have a more recent date than the bottom. The latter heating would have reset the TL clock to the present.

It is interesting that these age discrepancies all concern ceramic pieces probably reheated in a field fire. The two pieces heated in the forge were dated both at Oxford and Edinburgh to the 1920s .

Magnetic Data on Glozel Ceramics

Samples of several tablets were sent to John Shaw at Liverpool University to have their magnetic history analyzed. He was able to show that both of the vitrified tablets heated in the forge, as well as the phallic idol, had had an earlier firing, to above 700° C, followed by a later firing to about 400° C. Only the former heating could have effected the vitrification. Although the tablets may originally have been made and fired in the Celtic period, vitrification in a glass kiln would reset the TL clock, erasing any earlier firing.

He also determined that two tablets found in the tombs and dated to the medieval period had had earlier heatings. In this case the first heating would have been in the Celtic period and the second in the medieval period.

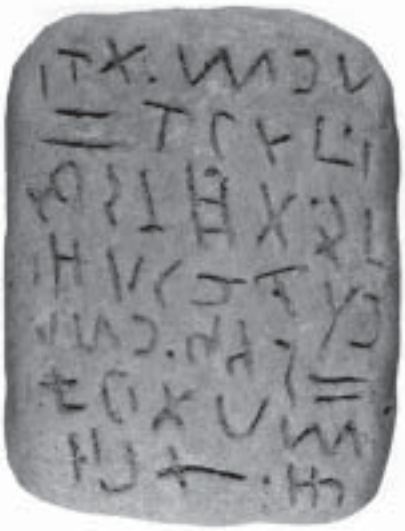
Discussion of the Ceramic Analyses

The TL data and magnetic analyses suggest that there are actually two occupation periods at Glozel, not three. The artifacts which seem to be associated with the earliest period are the inscribed tablets, the face urns, the vases, the phallic idols, the bobine, and the lamps. Hans Hitz has identified the writing found on many of these as a Celtic language originating as early as 300 B.C. and continuing to the third century A.D. The same writing is found on the Glozel schist bracelets, which although widespread in Iron Age Europe, do not occur after 300 A.D. A considered look at the evidence makes reheating the best explanation for the medieval TL dates found for some of these apparently older pieces.

The medieval TL dates seem to be associated with the glassmakers and are supported by the medieval C-14 dates and by the glass analyses. Hand prints, bricks with cupules, a tile from the floor of the kiln, and some pieces of clay all belong to this period. The recent period is an artifact of ceramic reheating.

The fact that all but one of the Oxford TL dates are medieval or modern has led to widespread distrust of the older TL dates from Edinburgh or Risö by establishment scientists in both Britain and France. This perception adversely affects the possibility of new excavations at Glozel. It is important that more TL tests, as well as C-14 tests, be performed in the hope of proving that the site was occupied in the Celtic period or even earlier. One prime candidate for TL dating is the vase found by Emile's daughter in the 1950s, which had a few letters on it and contained a ceramic necklace made of "bobines."

Ceramic objects from Glozel that seem to date to the Celtic Period



A face urn

A tablet

A vase

Two phallic idols

Bobbins

Lamps

Analyses Made on Bone

I: The Chemical Analysis of Bone

In Morlet's day, the only way of dating any Glozel material was by chemical analysis to find out how much organic material had disappeared from the bone since its burial. Modern techniques can convert these early measurements to determine the amount of nitrogen (N) remaining in the bone. Although nitrogen decreases with time, there is great variation in the rate of its loss. Modern bone contains about 4% N but Neolithic bone has been shown to range between 2.9% and 0.1% N.

In 1928 nine bone objects from Glozel were analyzed by Matheu and Randoin of

Ceramic objects from Glozel that seem to date to the Medieval period

Two bricks with cupules

A hand print

A tile from the fosse ovale

the Paris Police Laboratory as part of the Bayle report on Glozel. Conversion of their results reveals nitrogen levels between 0.3% and 2.5% for these objects — certainly not modern.

About the same time Morlet arranged for chemical analyses on eleven Glozel bones to be made at four European laboratories, including those at the Universities of Porto, Olso, and Lyon. Nitrogen levels for these objects ranged between 0.1% and 2.2%. Two awls, the poinçon found by the journalists of Le Matin, and a piece with a sculptured capride and letters found embedded in clay in the trench during the excavations of the Comité d'Etudes all had extremely low levels of nitrogen.

In 1976 Hugh McKerrell determined the amount of nitrogen in fourteen pieces of bone from Glozel, ten of them undecorated and non-human. The levels were between 0.2% and 0.7%. Matheu and Randoin had also analyzed a number of non-worked bones of sheep and calves found at Glozel; their converted nitrogen levels ranged between 0.0% and 0.6%, also clearly ancient. One wonders if this is any indication of animal sacrifice at an early period.

In 1997 Hugh McKerrell and Alice Gerard sampled 62 bones from the Glozel museum, twelve human bones and the rest worked or decorated animal bone. Nitrogen levels ranged from 0.5% to 4.2%. One of these artifacts, a fish hook, was chemically analyzed both in 1928 and in 1997. In 1928 it was found to have 2% N; in 1997 2.1%, demonstrating a good correspondence between the older and newer analyses.

II: Carbon-14 Dating

Sometime in the late 1940s, a good ten years after Morlet had stopped excavating at Glozel, he learned that a new technique — Carbon-14 — could for the first time accurately date old bone. Since bone loses C-14 at a measurable rate once an animal, or human, has died, a measurement of the remaining C-14 can give an age for the bone. Morlet sent a parcel of decorated bones to Harry Söderman, a former member of the Comité d'Etudes, who was temporarily living in the United States while writing his memoirs. Söderman gave the bones to Robert Gerard, a scientist at Columbia University's Lamont Observatory, and Gerard passed them on to Columbia's new radiocarbon laboratory for dating. Unfortunately, an advisory committee recommended against dating the bones and they were returned to Dr. Morlet.

In 1957 Morlet sent the same bones to the French radiocarbon laboratory at Saclay for C-14 dating. They were considered too fine to date; at that time a signifcant part of any small artifact would be destroyed in C-14 testing, since a large quantity of bone was needed for each test. Instead, Morlet sent two human bones to be tested. Both dated to the the 1950s, essentially modern, and the results were never published. At that time, bone was especially difficult to date by C-14 and the scientist who did the testing lacked confidence in these results. Since that time C-14 dates have been corrected to correlate with tree ring analysis, and McKerrell finds that the corrected dates for these bones could be anytime after 1650 AD.

Table 3 on the next page gives the results all of the C-14 dates, in historical order.

In 1975 McKerrell sent an ox tooth that had been found in a Glozel urn to East Kilbride in Scotland for C-14 testing. It dated to AD 30-230, very close to the TL dates being obtained at the time on Glozel ceramics. Than same year a sample consisting of fourteen pieces of bone was also tested at East Kilbride. The date, about 17,000 BC, was never published because the sample appeared to be contaminated with some kind of wax, which could not be completely removed. Fluorine levels found in these bones were exactly the same as in many other Glozel bones recently dated by C-14 to the medieval period, indicating that the very old date was not reliable. The fact that the bones were tested all together as one sample also invalidates the result.

Three C-14 dates were made in Oxford in 1984. A piece of charcoal dated to 1020-1220 A.D. and a fragment of an ivory ring dated to AD 1400-1490. A portion of a human femur was dated to AD 340-530. Unfortunately there is no record of the identifying number for the femur and no photograph. The charcoal had been removed from an inscribed tablet already TL dated to AD 1350±125; essentially both dates agree.

In 1995 Alice and Robert Gerard sent two small decorated bone tubes found in Tomb II in 1927 to the University of Arizona for C-14 testing using the Accelerator Mass Spectrometery (AMS) technique, which can determine a date from very small amounts of bone. To everyone's great surprise, the two dates were medieval: AD 1250-1300. These pieces were chosen in part because they had a good provenance; the tomb was excavated in one day under the direction of Esperiandieu of L'Academie des Inscriptions et Belles-Lettres.

Two years later, after McKerrell had begun to work again on Glozel, a new selection of bones to be dated was made after considering the nitrogen levels found by sampling artifacts at the museum. These included 984.2.132, a dagger handle decorated with reindeer and alphabetic letters; GF309, decorated with a troop of horses and alphabetic symbols; GF1716, depicting reindeer confronting each other; GF743, part of a

Tableau 2- Les Glozel Dates de Carbon-14

Objet	Date épreuvé	Laboratoire	Date de Objet
L'os humain	1957	Saclay	A.D.1690-1950
L'os humain	1957	Saclay	A.D.1670-1950
Dent de boeuf	1975	East Kilbride	A.D. 30-230
14 os	1975	East Kilbride	17,000 B.C. ?
Fragment d'anneau	1984	Oxford	A.D. 1400-1490
Charbon	1984	Oxford	A.D.1020-1220
Fémur	1984	Oxford	A.D. 340-530
GF1773 Tube d'os	1995	Arizona	A.D. 1250-1300
GF403 Tube d'os	1995	Arizona	A.D. 1250-1300
GF309 Troupeau	1997	Arizona	A.D. 1280-1410
984.2.132 Manche	1997	Arizona	A.D. 1260-1410
GF1716 Rennes affrontés	1998	Arizona	A.D. 1250-1390
GF743 Crâne	1998	Arizona	A.D. 1850-1955
202.2.154 Harpon	1998	Arizona	A.D.1520-1650
Charbon	1998	Arizona	>44,00 B.C.
GF755 Mandibule	2000	Arizona	A.D. 1450-1640
GF737 Fémur	2000	Arizona	A.D. 1440-1525
GF745 Crâne (même que GF743)	2000	Arizona	A.D. 1850-1955

human cranium recovered from Tomb I in 1927; and 202.2.154, a large harpoon made of deer antler with several alphabetic symbols on it. The first three dated to the medieval period, immediately raising suspicion they they were modern fakes made from old bone. However, examination of the engraved lines on two of these bones with the scanning electron microscope revealed that the engraving had been done when the bone was fresh, in the 13th century. The cranium, like the earlier human bones dated at Saclay, dated to AD 1650-1950 and the harpoon to AD 1520-1650. McKerrell also sent a piece of carbon from a vitrified tablet (984.2.006) to Arizona for dating. The date obtained, more than 46,000 years BP, suggests that the carbon was actually coal.

In 2000 René Germain arranged to have three pieces of human bone from Glozel dated at the Arizona laboratory. GF745, part of a the same cranium as the previously dated GF743, dated to 1850-1955 AD. GF755, a mandible, dated to AD 1460-1640 and GF737, a fragment of a left femur, dated to AD 1440-1525 (personal communication).

Discussion of the C-14 Results

An examination of the table below, which arranges the results in order of nitrogen levels, makes several things clear.

Tableau 4- Carbon Dates Arranged in Order of Nitrogen Levels

Objet	% d'Azote	Date
GF721 Fémur	.8 or 1.1?	A.D. 340-530
GF309 Troupeau	1.0%	A.D. 1280-1410
GF755 Mandibule	1.0%	A.D. 1450-1640
GF1773 Tube d'os	1.2%	A.D. 1250-1300
GF1716 Rennes affrontés	1.2%	A.D. 1250-1390
GF403 Tube d'os	1.3%	A.D. 1250-1300
984.2.132 Manche	1.4%	A.D. 1260-1410
GF737 Fémur	2.4%	A.D. 1440-1525
GF743, 745, Crâne	4.0%	A.D. 1850-1955
202.2.154 Harpon	4.1%	A.D.1520-1650

Seven artifacts have nitrogen levels between 1% and 2%. Five of them have been dated to the 13th century AD. A femur with 2.4%N dates to the late 15th or early 16th century, and two pieces with 4% or more N date to the 16th century or later. There is a clear, if not completely consistent, relationship between nitrogen level and age. Thirty-two of the fifty engraved or decorated bones analysed chemically in 1997 have levels between 1% and 2% N, suggesting that they may also date to the medieval period.

Four of the five human bones dated by C-14 range in age between the fifteenth and the nineteenth century. Seven out of twelve of the chemically analyzed human bones have nitrogen levels of 2% or more. One must conclude that most of the human bone we have tested at Glozel is at least several hundred years more recent than the decorated medieval bone.

Two bone harpoons have very high nitrogen levels — 4.0% and 4.1%. When tested, these drilled like fresh bone. These harpoons have been regarded with suspicion since the 1920s, and could be of recent manufacture. The one tested by C-14 dates to A.D.1520-1650 but could have been manufactured from old bone. We have nitrogen levels on another eight harpoons: four have 1% to 2% N, suggesting that they are medieval, but four have even lower levels and may be much older.

At present, the only C-14 confirmation for anything earlier than the medieval period at Glozel comes from the first century ox tooth found in a vase and the femur dated to the fourth century. The scientific community will not take Glozel seriously until older dates are obtained. This should be a priority, and the most likely candidates for early dates are bones with nitrogen levels below 1%. Although Matheu and Randoin listed six artifacts, Morlet eleven, and the 1997 analyses found twelve artifacts with levels of nitrogen below 1%, none of these have yet been carbon-dated

One good candidate for testing is the capride found by the Comité d'Etudes, with less than 0.1%N. Two of the awls analyzed by Couturier also had very low levels of N. Although these cannot now be identified, there are a number of awls and poinçons in the museum and none have been carbon-dated or analyzed for nitrogen levels in the last 70 years.

One may wonder what Dr. Morlet would say if he knew the results of the scientific analyses of the last forty years. I suspect that he would be shocked, but I believe that he was enough of a scientist and a Glozelian to accept the results as a challenge. He would tell us, “Don’t give up, keep on investigating. We must find the truth”

Many people have worked for decades to solve the enigma of Glozel. It would be tragic to give up the attempt when we are so close to finding important answers.

REFERENCES

Barbetti M 1976. Archaeomagnetic analysis of six Glozelain ceramic artifcts, *Journal of Archaeological Sciences*, vol 3, pp. 137-151.

Daugas J.P., Demoule J.P., Guilaine J., Mialler D., Petreqin P., and Poursat J.C. 1995. Resumé des recherches effectués à Glozel entre 1983 et 1990 sous l’égide du Ministre de la Culture, *Révue archéologique de la France*, 34:251-259, 1995

Gerard, Alice and Robert, Hitz, Hans-Rudolph, and Strong, Roslyn, 2001. Les anneaux de schiste de Glozel, *Actes du 4ème Colloque Glozel*, Vichy, pp. 11-30.

Hitz H-R, 1997. *Les inscriptions de Glozel,* Edition de l’auteur, Ettingen.

Hitz H-R, 1998. *Les inscriptions de Glozel,* Edition de l’auteur, Ettingen.

Hitz H-R, 1999. Une analyse de 1'écriture et du lexique de Glozel, *Actes du 2ème Colloque Glozel*, Vichy, pp. 41-69.

McKerrell H and Gerard A, 1999. L’Analyse et la Datation des Objects en Os de Glozel, *Actes du 2ème Colloque Glozel*, Vichy, pp. 111- 126.

McKerrell H and Gerard A, 1999. Les Analyses de verre et de poteries de Glozel, *Actes du 2ème Colloque Glozel*, Vichy, pp. 31-39.

McKerrell H, 1999. Les Datations des Céramiques de Glozel par la Thermoluminescence, *Actes du 2ème Colloque Glozel*, Vichy, pp. 17-29.

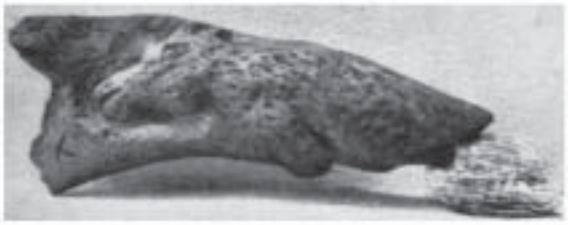
McKerrell H, Mejdahl V, Francois H, and Portal V, 1974. Thermoluminescence and Glozel, *Antiquity*, 48:265-272.

Morlet A, 1970. *Petit Historique de l’Affaire de Glozel*, Editions de la Source, Marsat.

McKerrell H, Donahue D, Gerard A and O’Malley J, 1999. La Datation au Carbone de Matériaux en Provenance de Glozel, *Actes du 2ème Colloque Glozel,* Vichy, pp. 89-95..

Zimmerman D 1976. Mesures de la thermoluminescence de grains de zircon extraits de deux prélèvements de Glozel, Etudes sur Glozel, *Revue Archaéologique du Centre,* vol. 57-58, pp. 29-30.

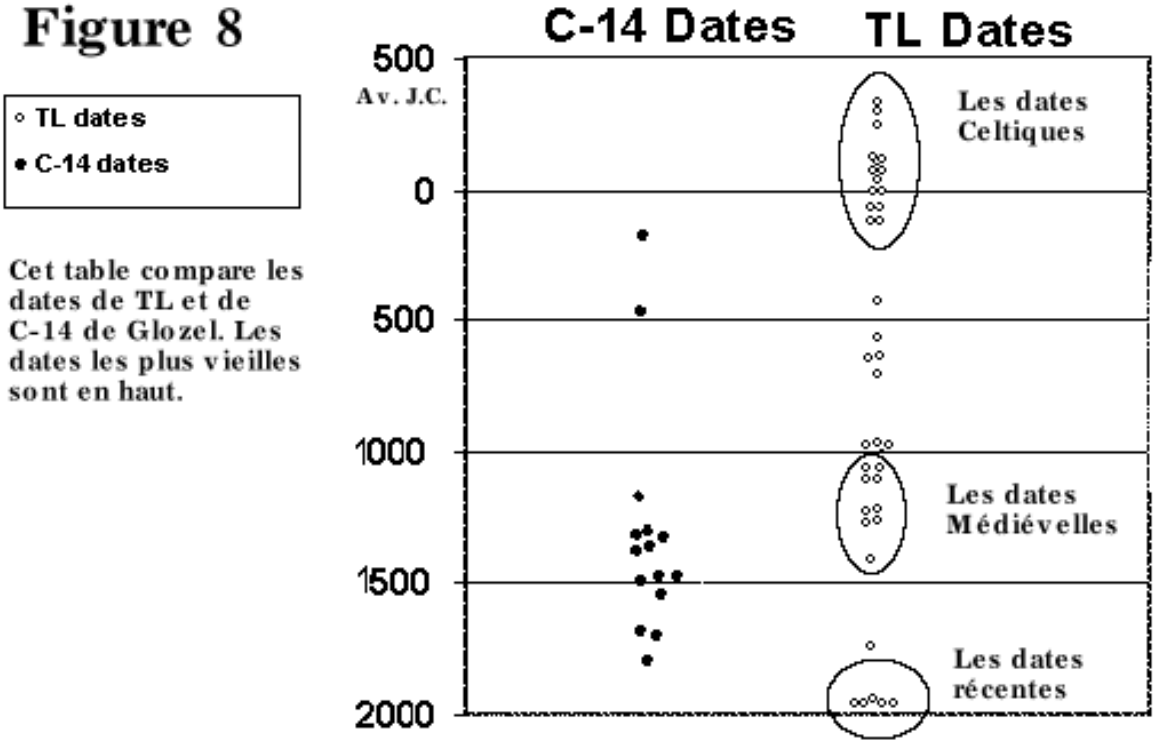
Figure 7 : Des objets avec moins d'un pourcent d'azote



Capride trouvé pendant les fouilles du Comité d'Etudes

Des poinçons: à gauche, pour les doigts, à droite, pour la paume

Figure 8



Cet table compare les dates de TL et de C-14 de Glozel. Les dates les plus vieilles sont en haut.