RELATIVE DATINGS WITH THE SCHMIDT TEST-HAMMER OF TERRACED HOUSE-FOUNDATIONS IN FORSA PARISH, HÄLSINGLAND, SWEDEN

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Introduction

The Schmidt Test-hammer, also known as an impact hammer or sclerometer, measures the distance of rebound of a controlled impact on a rock-surface. The distance of rebound (R) gives a relative measure, in percent, of surface hardness or strength. Low values (R=15-30) mean a soft and weathered surface, and high values mean (R>55) a hard, unweathered surface. The Schmidt Hammer is light and portable and allows in situ tests to be made in the field. It is also relatively cheap and has proved to be robust during extensive trials in variable conditions. With a test hammer large numbers of samples can be tested in a small area in a short period of time (Day & Goudie 1977). McCarroll (1987, 1989) has studied the instrument error, explained the sources of the error and made suggestions to minimize their effects.

The Schmidt Test-hammer has been used by geomorphologist for more than 20 years. The first published paper seems to be by Monroe (1966), who used the test-hammer to study case-hardening in Puerto Rico and in Indonesia. Yaalon & Singer (1974) used the hammer to study calcrete-crusts (Nari) in Israel. However, the most extensive field-studies with the instrument have been done by Matthews & Shakesby et colleges, who used the instrument in conjunction with lichenometry to examine the relative age of the outermost Neoglacial moraines in the Jotunheimen mountains in southern Norway (Matthews & Shakesby 1984). They concluded that, "This first application of the Schmidt hammer to glacial chronological problems suggest considerable potential for the instrument in the differentiation of the ages of Holocene deposits, particularly when applied in conjunction with other relative-age dating techniques, such as lichenometry".

In 1985 the Center for Arctic Cultural Research initiated a broadbased study of prehistoric and historic seal hunting cultures in the Bothnian region. One of the main goals of the project has been to date sites and features from the Late Iron Age and Medieval periods, about 1500 to 500 BP. Unfortunately many coastal sites from this period are found on rocky islands and shores, and consist solely of boulder and cobble constructions. For this reason the potentials of using lichenometry and rock weathering using the Schmidt Test Hammer in archaeology were investigated as part of the project (Broadbent & Bergqvist 1986, Broadbent 1987, Sjöberg 1987a, 1988). Time scales for lichen growth and weathering have been calculated from shore displacement rates (Broadbent 1979).

In Forsa parish in Hälsingland, central Sweden, fig 1, a number of localities with terraced house- foundations, dating to the centuries around AD, have been investigated, using the Schmidt hammer, to determine whether stone constructions on each site are contemporaneous. These investigation follow the method based on statistical processing of test- hammer data enabling comparisons of different sites (Sjöberg 1987a, 1988), described above.

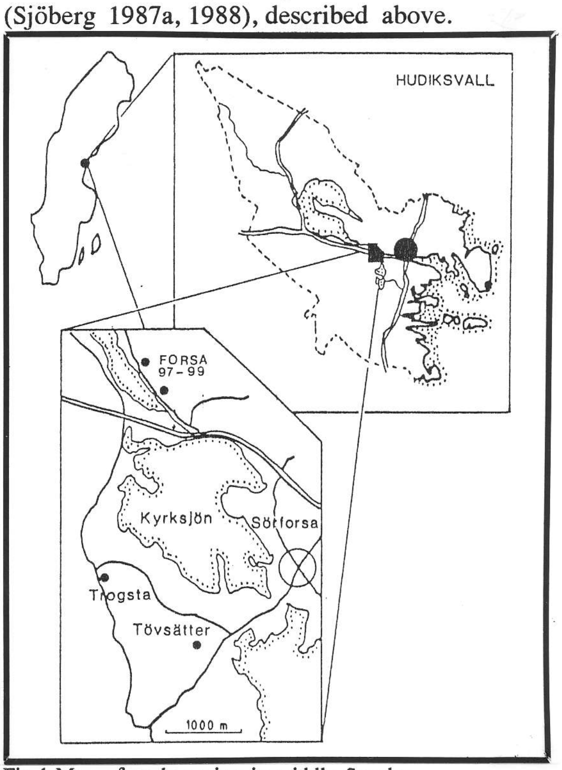

Fig 1 Map of study region in middle Sweden.

Research area

The researched localities are situated within a radius of 2 kms around Forsa church, ten kilometers west of the city center of Hudiksvall, in central Sweden. The landscape around Forsa is characterized by a zone combining a vaguely undulating coastal plain with hills reaching 75 m asl and the mountainous Norrland terrain, which in the area is very broken, with top-levels up to 360 m asl. The area is drained by the creek Rolfstaån, which in the researched area flows through lake Kyrksjön, with a present level of 34.7 m asl. The highest postglacial sea-level in the area is measured to 250 m asl (Lundqvist 1963). All of the localities are situated in a relatively coarse fractioned moraine.

The bedrock in the research area consists in the northern part of gneissgranites, which around Trogsta (se map, fig 1) turns into ögongneisgraniter (granites of Augengneiss type). The latter form the bedrock around the southern parts of lake Kyrksjön. Between the two big lakes Södra and Norra Dellen there is a geological site with volcanic rock, Dellenit. This bedrock has partly effected the content of bedrock types of the till in the Forsa-region, as the prevailing direction of the inland ice was towards the south-east.

Researched localities

Five localities with a total of 36 foundations were researched (Sjöberg 1987b). These were:

1. Raä Forsa no 98. Forsa parish.
This locality is situated on the north-eastern shore of Rolfstaån, 1 km NW Forsa church, and consist of a farm foundation with two terraced houses and a grave in the form of a cairn. This locality was together with no 99 excavated in 1987 by the county museum in Gävle (Melander 1989).

2. Raä Forsa no 99 Forsa parish.
This locality is situated immediately N of no 98. It consists of a couple of terraced houses, a number of cairns and a number of field cairns.

3. Raä Forsa no 97 Forsa parish.
This locality is situated immediately SE of no 98. It consists of the foundation of a big house, two smaller house-foundations and strings of boulders. It is considered to be of medieval age.

4. Raä Trogsta no 71. Forsa parish.
This locality is situated close to Trogsta village, on the western shore of lake Kyrksjön. It consists of the foundations of five terraced houses, a couple of smaller houses, twelve mounds of which two are fairly big and seven clearance-cairns. The site has been excavated between 1976 and 1981 by the Archaeological institute, Umeå university (Liedgren 1984). Carbon 14 analyses of charcoal from houses C and H indicate respective ages of 1900±170 and 1825±105 years BP Similar analyses from house A indicates a dating to the Migration period.

5. Raä Tövsätter no 160. Forsa parish.
The locality consists of the foundations of a 46 m long terrace to a house, a number of cairns and field-cairns. House A is one of the longest in the province of Hälsingland.

Method

As a norm for the localities 97, 98 and 99 ten bigger erratics in the coarse bouldery till above the localities were tested with a number of 91 impacts. On each foundation, cairn etc, a minimum of five boulders were tested, with a minimum of five impacts on each boulder. The statistical mean and median values, as well as the standard deviation, were calculated for the total number of R-values. Histograms for the percentile distribution of the R-values were constructed.

Results

The results of the investigation is summarized in table 1.

Interpretations

Forsa no 98 and no 99

The results of the tested erratics show a normal distribution around a mean of Rm= 39.2, RM= 40, and a standard deviation of ±10.3, figure 2. The standard deviation, table 1, is always great on metamorphic and magmatic bedrocks, which is explained by the different hardness of the containing minerals.

Locality no 98 is somewhat difficult to interpret and shows partly contradictory values. Some interpretations are, however, possible to make. The boulders on the terrace to house 98:1, figure 3, have a very interesting oblique distribution of the R-values, and especially the boulders which is thought to be the entrance to the house show values, which are clearly below those of the erratics. Two optima at R= 35

Table 1. Researched objects in Forsa parish, Hälsingland. Statistical mean (m) and median values (M), standard deviations (sd) and number of tested boulders and impacts (n boulders/n).

Site boulders/n tests	m	M	sd	n
eratics	39.2	38.0	10.3	10/91
FORSA 97				
house 1	40.3	42.0	9.3	5/32
terrace	42.0	42.0	5.9	5/39
house 4	42.5	44.0	6.5	5/39
FORSA 98				
house 1	36.7	36.0	8.3	5/41
stepps into house	43.4	46.0	7.6	5/34
cairn 4	44.2	44.0	8.2	15/170
house 6	36.3	37.0	8.8	7/66
boulders in wall	28.9	28.0	5.7	7/47
farm cairn 9	35.2	35.0	10.2	11/104
FORSA 99				
cairn 11	36.1	34.0	9.3	5/35
monolite in do	29.5	30.0	5.9	1/14
farm cairn 14	46.7	52.0	12.9	10.105
farm cairn 16	41.9	42.0	8.9	7/69
farm cairn 17	42.7	45.0	12.1	7/72
house 21	41.4	43.5	14.5	5/55
TROGSTA 71				
house A	35.3	35.0	8.2	5/33
house C	39.4	39.5	19.0	6/44
house D	36.6	38.0	8.7	5/40
house F	41.3	43.0	7.8	5/35
house H	35.1	34.0	6.7	5/43
edge of terrace A/B	39.9	39.5	7.8	5/40
cairn 11	30.8	30.0	8.6	5/42
cairn 12	35.4	35.0	12.4	5/43
cairn 13	41.8	44.0	9.6	5/35
farm cairn 15	35.2	34.0	6.1	5/30
farm cairn 16	36.9	35.0	6.0	5/28
farm cairn 17	30.1	28.5	6.9	5/37
erratic at B	34.0	33.0	10.6	1/31
TÖVSÄTTER 160				
house W side	31.3	30.0	6.9	5/34
house E side	34.6	35.0	7.9	5/50
cairn	33.5	31.5	8.2	6/42
cairn+grave+house	33.7	33.0	5.7	5/33

and R= 50 are clearly recognized (Sjöberg 1987b: fig 2b). The lower value when, compared to the localities Trogsta and Tövsätter, and no 98:1 above, may be thought upon as a normal value. The higher value can be interpreted as the surfaces of secondary polished boulders, where the originally weathered surfaces have been rubbed away by feet etc. The Rm-value of a fresh polished boulder surface, eg at shore level, is around 60. This lower value (Rm= 50) might show the degree of weathering since the house was abandoned.

Site 98:4 has been interpreted as a grave-cairn contemporary to the house-terrace. The distributions of the R-values, figure 3, seem to indicate that new

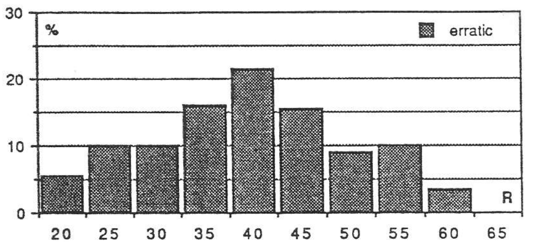

Fig 2. Percentile distribution of R-values from ten erratics, above Forsa no 98 and 99. The distribution is normal around Rm=40.

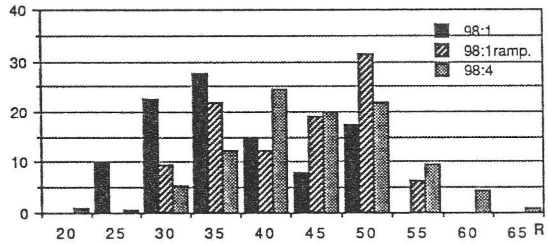

Fig 3. Percentile distribution of R-values of boouIders in house-foundation Forsa no 98:1, rampart of 98:1 and grave cairn 98:4. The distribution of 98:1 is oblique with two maxima R=35 and R=50. The lower value is considered as normal. The higher value can be interpreted as secondary polished. 98:4 is a grave where the values indicate that new boulders have been put onto the cairn.

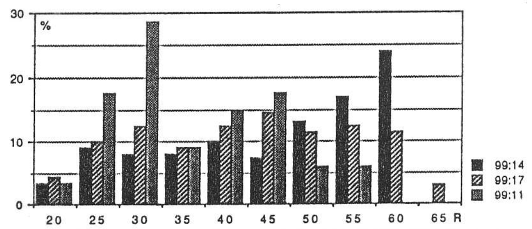

Fig 4. Percentile distribution of R-values of boulders in field-cairns Forsa no 99:11, 14 and 17. The bimodal distribution of cairn no 11 indicate that a contemporary cairn has been covered by younger material. Cairn no 14 and 17 are contemporary cairns covered by very young material.

boulders have been put onto the cairn at a later occasion.

Locality no 99 is situated nearby to the latter (98), and is only divided from this by a small creek. It has been regarded as a contemporary to locality 98. One of the terraced houses (99:21) show a very split distribution of the R-values, from which it is not possible to draw any conclusions.

Four of the tested field-cairns (99:11, 14, 16 and 17) initiated interesting interpretations. Field-cairn 99:11 show a bimodal distribution which probably indicates that a contemporary cairn has been covered by younger material. Cairn no 99:14 show a very clear oblique distribution, which might be interpreted as a contemporary cairn, on which new boulders, dug out from the ground, have been put on a much later occasion. Similar, but not as clear oblique distributions are found on cairns 16 and 17, figure 4.

Forsa no 97

On locality no 97 the tests show clearly higher results than those of no 98 and 99, with a Rm= 42. This must imply that the locality is younger than the pre-vious ones. The locality has not been excavated, but archaeologists interpret the locality to be of Medi-eval age.

Trogsta no 71

The tested foundations of houses A, D and H show very similar Rm-values, varying between 35.1 and 36.5, figure 5. The distribution of the R-values for house A and D show an optimum around R=40 The test-value for house C is Rm= 39.4,which is comparable to the edge of a terrace between house A and B (Rm= 39.8). A higher value is found on house F (Rm=41.3). As in houses A and D the optimum value is around R=40. From the distribution of R-values and statistical means it can be evaluated that, all these houses, except for B and F, are contemporaneous.

Of the researched field-cairns (nr 13, 15-17), number 15-17 show similar means (Rm= 30-35), as well as optimas in the distribution of the R-values. Totally different is the little cairn no 13, with Rm= 41.8 and an optimum in the distribution at R= 45, figure 6.

The interpretation of the results from Trogsta, should be that house H, which is partly built over by a grave-cairn is the oldest, and the small houses B and F are the youngest. The field-cairns are presumably contemporaneous with the investigated houses, with the exception of field-cairn no 13, which seems to be definitely younger. The morphology of this cairn is also different from the others.

Tövsätter no 160

This 46 m long terraced-house was tested both on the eastern, and the western short-side. Even though the Rm-values are similar (34.6 and 31.3) the distribution of the R-values are very different, figure 7. The values from the eastern short-side show a very oblique distribution, while the distribution of data from the western side have a normal distribution, gathered around an optimal value of R= 30. This difference in the distributions may be explained by difference in petrology. The two investigated cairns

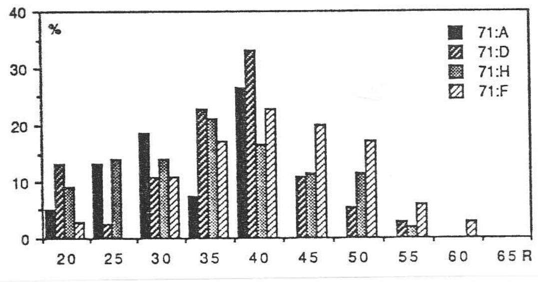

Fig 5. Percentile distribution of R-values in foundations of the houses Trogsta 71:A, D, H and F. Four almost contemporary houses. The results indicate that house H is the oldest and house F is the youngest.

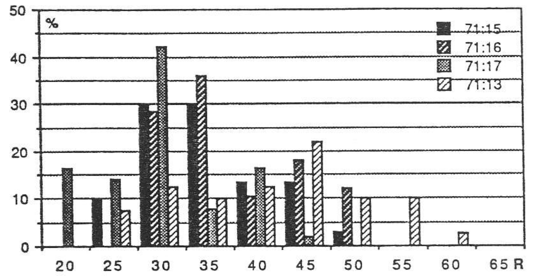

Fig 6. Percentile distribution of R-values in field-cairns Trogsta no 71:13-17. Cairns no 15-17 are contemporary and older than cairn no 13.

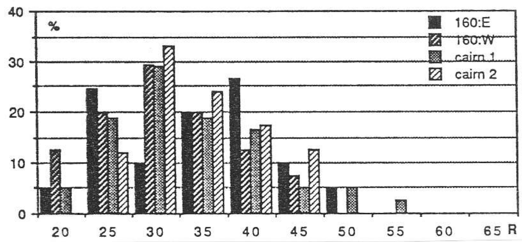

Fig 7. Percentile distribution of R-values from two terraced house-foundations and two cairns at Tövsätter no 160. The house foundations and the cairns seems to be contemporaneous.

show similar distributions, figure 7, and Rm-values (R=33.5 and 33.7). This indicates, that the different foundations at Tövsätter ought to be contemporaneous.

If these results are used for a relative dating of the localities and the tested sites, it seems as though the foundations of the terraced houses and the cairns at Trogsta and Tövsätter are contemporaneous and older than the terraced houses in Forsa, where Forsa 97 is younger than Forsa 98 and 99.

"Absolute" datings of the localities

The investigated localities are situated inland, and too far from the coast, and the building-material is mixed up with too many boulders containing bed-rock from the Dellen-formation, compared to raised boulder-beaches along the coast. That means that the normal precidia with a weathering regression line for a local raised boulder beach can not be used. Thus a local weathering regression line had to be constructed.

Table 2. Features used for "absolute" datings, Rm-value and age.

Site	Rm	age AD	remarks
Trogsta 71:A	35.3	400	^{14}C
-"- 71:C	36.6	100	"
-"- 71:H	41.3	100	"
Forsa 97	40.3	1300	typolog
-"- 97	42.0	1300	"
-"- 97	42.5	1300	"
Forsa late medi-eval. house	46.5	1400	"
Forsa, bridge	42.8	1750	typolog
-"- -"-	44.8	1800	"
-"- -"-	50.0	1900	
Wall around Forsa church	47.3	1800	
-"-	42.4	1900	

To construct this local weathering regression line, previously dated features made of stone had to be used. Thus, the sites, dated by ^{14}C to the first centuries AD at Trogsta, were used as the lower part of the regression line. For the middle part the medieval site Forsa no 97 was used, combined with a late medieval house close to the church at Forsa. The old medieval church in Forsa was not useful for testing, as it is plastered. Crossing the river Rolfsta-ån, at Forsa, is an old bridge, the fundaments of which can typologically be dated to the 18th century. This bridge has been reconstructed with stone-material in the 19th and early 20th centuries. A wall made of bedrock material was constructed around the church-yard in the 19th century, and was rebuilt in early 20th century. These latter features were used to con-struct the upper part of the regression line. All the sites were tested, using the same method.

The regression-line constructed of these features follows the equation

$$Y = 121.9X - 3946$$

where X = Rm-value, Rxy = 0.75, with $p < 0.005$. The equation has however the very high standard deviation of ± 469 for years.

The "absolute" age of the tested terraced houses and cairns where calculated, table 3, and plotted against this regression-line, figure 8.

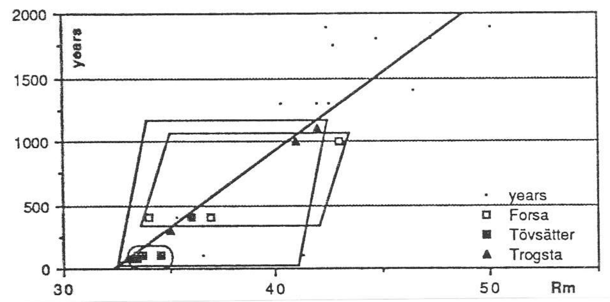

Fig 8. Regression line for "absolute" datings in Forsa parish, and attempts to use the test-hammer method for "absolute" datings of investigated sites.

Table 3. "Absolute" datings of investigated sites in Forsa parish, site, Rm, calculated age AD, and ^{14}C datings.

Site	Rm	AD	^{14}C date
Forsa			
98:1 house	36	400	200-400
98:9 house	36	400	
99:1.cairn	36	400	
99:21 house	41	1000	
Tövsätter			
house	33	100	
cairn	33	100	
cairn	33	100	
Trogsta			
71:D house	36	400	
71:F house	41	1000	
71:12 cairn	35	300	
71:13 cairn	41	1000	
71:15-17cairns	33	100	

Discussion

The constructed weathering regression line should not be regarded as definite, as several sources of error are built into the data. The boulders of the medieval house at Forsa church are more of Del-len-volcanics type, than of Augengneiss-granite or Gneissgranite, which are dominant in the researched localities. The building material in the old bridge might not be of local bedrock. The upper, relatively new parts of the wall around the church-yard have too low values for the boulders to have been cut when the wall was reconstructed. It might well be that the wall was built of material from an older wall around the church. This is likely, compared the Rm-value from the older parts of the bridge. And, as previously stated, all Rm-values of metamorphic and metamorphic rocks have a high standard deviation.

Despite this, the results and interpretations of the relative and absolute datings can be discussed. ^{14}C

analyses from Trogsta indicates that the houses C and H were used around AD 100-200, and house A around 400 AD (Liedgren 1984). Similar analyses from Forsa suggests that house 98:1 was used around AD 200-400, and that house 98:3 and 99:4 were used around 300 AD (Liedgren 1989:70, Melander 1989).

Test-hammer values, according to the local weathering regression line, give the site at Forsa an age of 400 AD, with one extreme-value of 1000 AD for a field-cairn. These datings are in agreement with the ^{14}C datings. This also include the field-cairn (no 98:11), where the distribution of samples show a double peak, and the lower peak with R-values around 30, indicates an age of 200 AD. House D at Trogsta is, by this method, dated to 400 AD. This value is also very probable in view of the ^{14}C datings of neighboring houses. So are the values for the cairns no 12 and 15-17. House F is dated to 1000 AD, but this value is not consistent to the ^{14}C dating of the same house (400 AD). The test-hammer dating of cairn no 13 to 1000 AD seems to be contradictory to the other constructions at the locality. As the morphology of this cairn is very different from other cairns, at this locality, the dating at least tells us that this cairn might differ in age from other features at Trogsta.

Conclusion

The Schmidt test-hammer, originally constructed to measure the quality of concrete, has been proved to be a useful tool for applied archaeological research. Despite all the sources of error in this method, Schmidt hammer tests seem to give very valuable, fast, and not at least inexpensive, directing relative datings of archaeological features, where no dateable artifacts give a more secure dating.

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