7 Fabric composition, Uitgeest-Gr.D. and Schagen-M1

7.1 Clay and temper

The analysis of the relationships between clay composition and temper is the first level of data integration and aims to characterize the total fabric composition observed in the pottery. The general research-question is whether the potters varied the amount or size of temper because of the composition and properties of the clays they used: to the type of clay and/or the type and quantities of inclusions and/or to the quantity of quartz (>150 μ).

In chapter 5, three types of clay were defined for the pottery samples, based on their similarities with the test clays (chapter 4; fig. 1). Clay types 1 and 2 are similar to test clays 65 and 62+64 respectively; both types have comparable amounts of iron and similar apparent porosity curves (fig. 4.2), but vary considerably in the amount of calcium (table 4.3). Clay type 3 is similar mainly to test-clay 63, which has a slightly higher calcium content as well as a slightly higher percentage apparent porosity than the other two. Clay 63 moreover showed the peculiar colour lamination when fired at higher temperatures, probably a separation of calcium compounds within the overall iron-rich matrix (fig. 4.1).

In the samples of sherds from both sites, no statistically significant relationship between the type of clay and the type or quantities of inclusions was found. The amount, volume and size of temper in the sherds show some association with the apparent porosity measurements in both samples (tables 6.8 and 9), but the influence is much weaker than expected on the basis of the test tablets (fig. 6.2). The type of organic material used as temper most likely consisted of chopped and rubbed parts of plants, rather than dung. As the %AP is a measurement for the total fabric composition, measuring the combined effect of the clay composition, temper and firing temperatures, this variable is used to analyze the relationships between clay and temper variables.

7.1.1 FABRICS UITGEEST

Most of the pottery was made of clay type 1 or 2, with a smaller percentage (23%) made of clay type 3. The quantities of quartz grains >105 μ are quite low, mostly less than 25 per 3 × 3 cm, and are independent of the clay types. Most sherds contained inclusions, but in varying amounts. The amount and size of temper varied around a standard of circa 15 vol% or 30 to 60% areal density (table 7.1a,b).

Fig. 7.1a shows the relationship between the amount and size of temper and the type of clay for all sherds together (n=125). Although the relationship between the clay types and the %AP is not significant (table 7.1c), the distribution suggests there is some variation in the %AP connected with the clay type and amount of temper. To clarify the complex relations, those between temper variables and the %AP are shown separately for each type of clay. The distributions in figs. 7.1b-d confirm that the %AP does vary to some extent with the type of clay. In sherds assigned to clay types 1 and 2, the range in the %AP is quite similar (mostly up to 39 %AP) and the values are in general slightly lower than those for sherds made of clay type 3. For sherds made of clay type 1, no influence is visible of the amount or size of temper on the %AP, nor is there any relation with the type or quantity of the inclusions (fig. 7.1b; 7.2a,b). For those assigned to clay type 2, the relations between the temper variables and %AP seem to be variable (fig. 7.1c). The %AP shows a wide range for sherds with up to 50% AD of temper. For higher amounts the %AP tends to increase with the amount of, especially coarse, temper. Most of these sherds have type A- and/or Ca-inclusions, but there is no correlation between the type or quantity of inclusions with the %AP or %AD (table 7.2).

For sherds assigned to clay type 3, the %AP is not only higher on average than in the other two, but is increasing with higher amounts of temper as well as with the amount of coarse temper (fibres >3 mm) in a much more 'regular' manner. 30% of these sherds contained more than 5 fibres >3 mm in the standard area (28% and 22 % respectively for clay 1 and 2). In this light it is rather surprising that the X^2 for the relation between the vol% and the clay types points to a non-random distribution (fig. 7.2c; table 7.1b). The 'significance' is, however, exclusively due to the higher than expected vol% for clay type 3 (class 3), the same being true for %AD (fig. 7.2a; table 7.1a).

It is not clear whether the very slight differences represent a meaningful distinction in overall fabric composition. Altogether, the distributions (especially fig. 7.1b-d and 7.2c) suggest, that the %AP is hardly influenced by the amount or

volume % of temper, *if this is lower than ca 60 %AD or 20 vol%*, for each of the clay types. Higher volumes of temper increase the porosity in sherds made of clay type 3 and part of those of clay type 2. Considering the distribution for the latter (in fig. 7.1c), it is possible that this group of sherds represents two slightly different fabrics: one which is very similar to clay type 1, in which the %AP is not influenced by the amount of temper, and one more similar to clay type 3. There is no connection, however, with those cases defined as the intermediate clay type 1.2 (which was added to clay type 2 in the tables for Uitgeest, see table 5.2). Compared to the test tablets of set C (chapter 6.2), the average and range of the porosity in the sherds is slightly lower for the same vol% of temper (comparing the three classes of 0-10, 10-20 and 20-30 vol% of temper), but they are clearly higher compared to the tablets tempered with dung. On of the reasons could be the difference in firing temperature; the test-sets with temper were fired at 750 °C, while the pottery may have been fired at slightly higher temperatures, up to 850, °C and thus vitrification would be more intense. This is to some degree supported by the %AP values for the untempered test clays (fig.4.2). Although the clay samples were not fired at 750 °C[1], the %AP rises sharply between 700 and 800 °C for clay samples 62-65 (fig. 4.2), followed by a slight decrease at 850 °C.
The type or amount of inclusions had no obvious influence on the %AP (fig. 7.2b) nor on the %AD of temper (table 7.2a,b) or the amount of coarse temper. Both variables show a completely random distribution in connection with the clay as well. The same lack of statistical significance was observed for the amount of quartz particles >105 μ and the amount of temper in the sample of 188 sherds (table 7.2c). However, the small number of sherds with more than 50 quartz particles in 1 cm^2 (table 5.6, part of class 3) all have less than 40 %AD of temper. This could indicate that the amount of quartz was taken into account by the potters. Altogether, it can be concluded that there is some limited interaction between the type of clay and the amount and size of temper in their influence on the apparent porosity of the total fabric; this influence is mainly restricted to the fabrics of clay type 3. It is possible, that the pottery made of clay type 3 to which also more coarse temper was added, represents a special group of pottery, for which high porosity was desirable. For the majority of the pottery, there are no signs that the amount of temper was adapted to specific properties of the clays, at least not for the variables tested here. There are several possible explanations for this lack of clear correlations between fabric variables. *Firstly*, the method to define the clay types may be too imprecise to catch the real differences between various batches of clay and therefore obscure the relationship with temper variables. One obvious reason for this lack of precision is the postdepositional change of the pottery (see below). On the other hand, the composition of test clays nr. 62-65 on which the types are based, are very similar in chemical composition and firing properties to those observed in the sherds, both by macro- and micro techniques. In general then, the assignment of the clay types in the pottery seems to have been correct, although to some extent influenced by the secondary changes. *Secondly*, the %AP is not the 'ideal' indicator of fabric composition it is supposed to be. The variation between sherds of different parts of one vessel confirmed that many factors influence the measurements in 'real' and buried pottery. For the poor correlation between clay types and the amount of temper, the *third* explanation, offered in chapter 5.4, is the most likely one. If the potters selected clays with a certain, more or less standard composition and properties, then the amount of temper to be added would not have to be varied in relation to the clay, but only in relation to the *function* of the vessel (see chapter 9). The minor variations in the composition may not have been noticeable for the potters and/or not considered as important. With only a slight shift in the level of analysis, the fabrics from Uitgeest could easily be described as 'similar'.

Fabrics and contexts
As the sample represents at least two centuries of pottery production, chronological changes in paste composition could be another reason for the random variations in the sample of fabrics. To check this possibility, the fabrics of pottery from the few closed contexts (several of the wells) and those from features for which a relative dating was established (features 23, 27, 28 in trench 35; see figs. 3.5 and 3.6) were used (table 7.5). As was shown in the previous chapters, this sample gave no indication for a chronological influence in the type of clay or inclusions or the amounts of temper and the same must be concluded for the combined data. Because most of the pottery from well 18-1 was burnt, it may not be suitable as a control sample. The sintering could have affected the definitions of the clay types as well as the counts of the amount of temper, and it caused very likely the extreme range of porosity measurements (from 31.9 to 44.4 %AP) in these vessels. However, none of the variables show exceptional values compared to the total sample. The C-14 date of this well is close to that of well 8-1 and well 31-1 (table 3.1). The pottery from the latter two show no indications for a specific range of temper or of porosity values either, although the types of clay are more restricted in each case. Feature 23 is the oldest in an area with many occupation remains; most pottery was made of the iron-rich clay type 1. Feature 22 is also a relatively early ditch; the pottery was made of clay types 1, 2 and 3. Both are probably earlier than feature 27, with pottery made of clay types 1 and 2, and feature 28, certainly one of the

latest in the area, and with pottery of all clay types. Although the number of cases is too small to draw a firm conclusion, there are no indications for a systematic difference in the amount and size of temper nor for porosities in this pottery.
The data do raise questions, however, about the methods for classifying the clays. The presence of combinations of clay types in a closed context suggests that either the potters selected different clays for specific types of pottery or the method to define these clays is insufficient or even faulty. The first option is explored in chapter 8 and 9; the second could again point to changes of the fabrics after deposition. A third and alternative explanation, mentioned above, is that the variations in these clay types were not distinguished by the potters. In that case, the pottery in the features discussed, may represent a difference in the batches of raw materials, in time of production, and in the locations from which the clay was extracted. This explanation would fit the data for the clay samples from Uitgeest and especially Schagen, as the clay samples collected within a very short distance of each other do show a difference in chemical composition, at least at the micro-level. Again, this explanation indicates that the potters did not distinguish between the clay types defined for the pottery.

7.1.2 FABRICS SCHAGEN

More than 50% of the pottery in the sample was assigned to clay type 2; sherds assigned to clay type 3 form a small group (n=12; 21%). For an equal number of sherds the clay type could not be defined, due to extreme secondary infiltrations of iron (clay type 1; n=12)[2]. Virtually all sherds contained inclusions, often in large amounts, which sizes, especially of the clay pellets, can be quite large. The amount of inclusions in the sherds was not measured; instead, the measurements of the maximum size of clay pellets in each sherd is used in table 7.4. In pottery from Schagen, the average %AP as well as the range is higher than in the test clays of set C; the %AP varies from 24 % to 48 %. Relationships between all fabric variables were explored, but, as was expected after the analyses in chapter 5 and 6, the data show no significant association between any combination of variables (table 7.3, 7.4). The %AP of clay type 3 is slightly higher than expected, that of type 1 slightly lower. Fig. 7.3a,b shows that the rather odd distributions of the %AP and %AD are mainly restricted to sherds made of clay types 1 and 3. There is no association with the type of inclusions. In some of the sherds with high amounts of coarse temper, the amount of coarse fibres seem to have a *reverse* influence on the %AP (fig. 7.4a,b)[3]. In sherds of clay type 2, on the other hand, the average %AP is increasing to some extent with higher amounts of temper, while for clay type 1 there is no difference. The %AP is also higher for sherds of clay type 2 and 3 than 'type 1'; these differences are not caused by the amounts of temper (fig. 7.4a). There are no interrelations between the amount, volume or size of temper and the type of inclusions in the fabrics either (table 7.4a-c). The only tendency apparent in table 7.4c is that sherds with very large clay pellets tend to have a slightly higher %AP, but this is independent of the temper variables (table 7.4b).
Altogether the partly conflicting results are difficult to interpret and it is hardly possible to draw any meaningful conclusions from the present data. The one firm conclusion is that the fabric analysis was seriously hampered by the post-depositional changes in the pottery. It is quite likely that the differences in porosity between the clay types are the result of secondary changes. In the sherds labelled as clay type 1 (with heavy infiltration of iron), the infiltration may have resulted in the blocking off of the pores. Another tentative conclusion is that the on average lower amount of temper added to the clay, compared to Uitgeest, must in some way be related to the amount of natural inclusions in the clay, although it is not supported by the available empirical evidence. The often coarse inclusions are comparable to coarse 'temper' as far as fabric properties are concerned and it is likely that their presence added to the high porosity measurements for the Schagen sherds. As virtually all of the fabrics contain inclusions and as most of the fabrics are made of type 2 (or 1 and 2, see note 2), the potters may have adapted the amount of temper to the clays they usually used and did not change their recipes for minor variations in this composition.

Fabrics and contexts

Pottery made of clay type 3 occurred exclusively in pits and not in surface features, while a higher percentage was found in features in the Southern area, in the dwelling and its immediate surroundings (table 5.9). At the same time, most of the vessels with an extremely high %AP also were recovered from features in the southern occupation area: excluding the cremation urns because of possible secondary burning, 60% of the vessels from the southern area has a %AP > 39.5, against only 30% from the northern area (table 7.6). The data do indicate a possible relation between clay type 3 and the %AP in the sherds. The range of the %AP in pottery from the northern part of the settlement is much more similar to that of Uitgeest and to the test tablets of set C, from 32-45%, with 26 as the one exception. These context variations are not associated with differences in the amount or size of temper nor the type of inclusions. The natural conditions after deposition surely are one of the underlying factors causing the spatial differentiations. Most vessels from the southern area are recovered from pits and very few from surface features (only from the hearth, feature 194). These trends support the conclusion that the %AP is influenced by the secondary infiltration of iron and manganese; either more infiltration resulted in a lower porosity, or, vice versa, leaching and/or dissolving of particles in the clay by the acidity of the ground water resulted in a higher porosity of the vessels. Such changes could explain the lack of any relationship between the porosity and the fabric composition.

7.2 Summary and conclusion

In this section, some conclusions are drawn with regards to the hypotheses and research questions, presented in chapter 2.5.3.

Paste composition

The analyses of fabrics of Schagen and Uitgeest indicate that the potters in both sites selected specific clays, clays with a specific and limited range in their composition and properties. These clays contain only low amounts of quartz particles >105 μ in Uitgeest and none in Schagen. The pottery fabrics of both sites are most similar to that of the three clay samples 62-64 taken from Schagen with respect to the amount of calcium and iron, as well as the ratio of these elements. While most of the pottery was made of clays like samples 62 and 64, a small group in both sites was more similar to sample 63, with a slightly higher Ca : Fe ratio and apparent porosity (see below). It can also be concluded, with some caution, that the clays were not given any specific pretreatment, considering the variable amount and type of inclusions. Vice versa, their presence could be interpreted as a deliberate choice of clays with a certain amount of plastic or nonplastic nodules. Next to the similarities in chemical composition, the fabrics at both sites show differences that point to the local origin of the raw materials.

The fabrics from *Uitgeest* are all rather heterogeneous in texture and structure. Small, rounded quartz grains up to 600 μ, nonplastic inclusions and clay pellets were present in variable amounts, indicating that they were natural constituents in all clay types. In the case of *Schagen*, where the fabrics frequently contained large sized inclusions, it is even possible that clay pellets were added to the very fine-textured clay by the potters. The reason could have been to improve the workability and prevent cracking during drying and firing.

If the interpretation that the potters selected specific clays is correct, this can partly explain the lack of clear and statistically significant associations between clay types (including the inclusions) and the amount of temper. If the potters started with the choice of clays and their general properties, then the amount of temper that was added, would be determined mainly by the function of a vessel. The amount of temper shows a slightly skewed normal distribution for both samples, indicating that there was a standard amount for most of the pottery. In the sample of Uitgeest, the standard amount was between 30-60 %AD and between 10-20 vol% of temper, in the Schagen sample the majority of the pottery contained circa 10 vol% or 25-50 %AD. The difference may have been linked with the ubiquitous presence of natural inclusions in the clays, which could have been regarded as a substitute for, or an addition to the organic temper.

The 'standard' quantities can then be interpreted as the basic or standard recipe for the most frequently produced group of pottery in both settlements. Variations in the amount of temper and/or slight variations in the type of clay may have been used for specific groups of pottery (see chapter 9). Perhaps the pottery made of clay type 3, at least that from *Uitgeest,* is such a group. The naturally high porosity of the clay was enhanced by also adding slightly more, especially coarse, temper to the paste, suggesting that the potters were trying to make fabrics with specific properties (see chapter 9). In the fabric sample of *Schagen*, there are also some indications for the existence of a second recipe with higher amounts of temper, but there is no clear connection with the type of clay or inclusions, nor with the porosities. The rather high %AP found in this sample is probably caused by the inclusions. However, both the definition of the clay types and the %AP measurements for the sample from Schagen are heavenly influenced by postdepositional changes.

It can be concluded that the level of differentiation in fabric composition is very low indeed; most of the pottery is made of the same types of clay with the same amounts of temper. The overall technology in the process of step 1 up to step 3 in the model of fig. 2.4 is thus consistently a standard one in which very few specific variations were applied. The potters may have had a second recipe, with higher amounts of temper and/or using a clay with a higher %AP for a specific group of pottery. More research with larger samples is necessary to define such a second standard, if there is one.

Furthermore, the composition of the fabrics indicates that new pots must have been highly porous and perhaps even permeable, depending on the specific surface finishing. In other words, most of the vessels were probably not waterproof. The question is wether specific measures were taken to prevent leaking. Several methods to make vessels waterproof are known from ethnohistorical sources (Thompson 1958)[4]. These methods will all cause a reduced permeability and this might influence the %AP (even if not influencing the true porosity) by blocking off the pores from the surface. Moreover, the use of pottery, especially as cooking pots leads to the intrusion of the content's fluids into the wall of the vessel, filling up the pores from the inside. The relation between the rather undifferentiated use of temper with the functions of the pottery is further analyzed in chapter 8 and 9. Finally, as far as could be established, there are no indications for a change in technological traditions within the settlement of Uitgeest.

Firing techniques

The firing process as inferred from the pottery was rather uniform for both sites. The standard procedure was to fire under neutral to lightly oxidizing circumstances. The presence of carbonized remains, the usually dark grey to black colour of the core and the low degree of oxidation of the surface of the pottery all point to a short duration of the firing process, although the maximum temperatures reached were probably not higher than 850 °C. The supply of oxygen during the entire process was rather low in general, resulting in an incomplete and inhomogeneous degree of vitrification of the raw materials[5].

Special treatment was given to a small group of pottery that was reduced at the end of the normal firing procedure through smudging. These vessels always have a highly polished and shiny black surface. Neither the clays nor the amount of temper of these vessels differed from the other pottery in both sites. These 'special' vessels are clearly part of the local range of products and techniques, but were to have a special appearance. As will be argued in chapter 8, this type of vessels probably had a special function, expressed by the combination of form, surface treatment and firing method.

Test clays, pottery and post-depositional changes

Part of the variations seen in the fabrics of the pottery from both sites, but especially that of Schagen, is directly caused by postdepositional changes, consisting of (a) infiltration of mainly iron and manganese compounds in and around the core and (b) the dissociation and leaching of other, probably calcium rich compounds, mostly from the surface layers. Both changes affected the fabric research negatively, especially the chemical analysis, but also the definition of the clay types in the pottery, through changes in the colours of the surfaces and cores. The overall result of the fabric analyses is quite disheartening in this respect and only increased my initial scepticism about the value of chemical analyses and other methods for typing fabrics, such as the apparent porosities. The %AP of a random sherd from a vessel is not the quick and easy way to establish fabric properties, but is unfortunately a rather imprecise measurement, affected by many factors in buried ceramics. The evidence showed the major problems involved in fabric analysis and interpretations, which to a large extent cannot be solved with the available methods. On the other hand, the results are also encouraging in the sense that despite these problems, the combined use of local test clays and simple observation methods did allow some basic conclusions to be drawn. In this respect, the low precision of the analytical level was an advantage.

notes

1 The reasons for firing the tempered test tablets at 750 °C are discussed in chapter 6.2.

2 For the fabric sample of Schagen, sherds assigned to clay type 1.2, intermediate between 1 and 2, were added to clay type 2; 'type 1' was used for sherds with so much secondary infiltration that no definition was possible (see chapter 5.2).

3 Even though there are no indications that the batch of sherds in the cluster in fig. 7.3a, was treated differently in any way, the most feasible explanation seems to be that somewhere in the procedures measuring errors have been made.

4 The pottery made for experimental purposes from Dunkirk 0 and IA clays from Midden-Delfland sites were all leaking initially (Olthof 1997). When the vessels were filled with high-fat milk, the leaking stopped after circa 2 hours and the vessels remained waterproof during the cooking experiments.

5 An additional factor could be the difference in size and shape: the size of test tablets allows a much greater access to oxygen than a complete vessel. Although depending on the way they were placed in the fire, the oxygen will penetrate the vessel wall mainly from the outer surface.

Fig. 7.1 Uitgeest-Gr.D. sample 1. The relationship between temper variables and clay types.

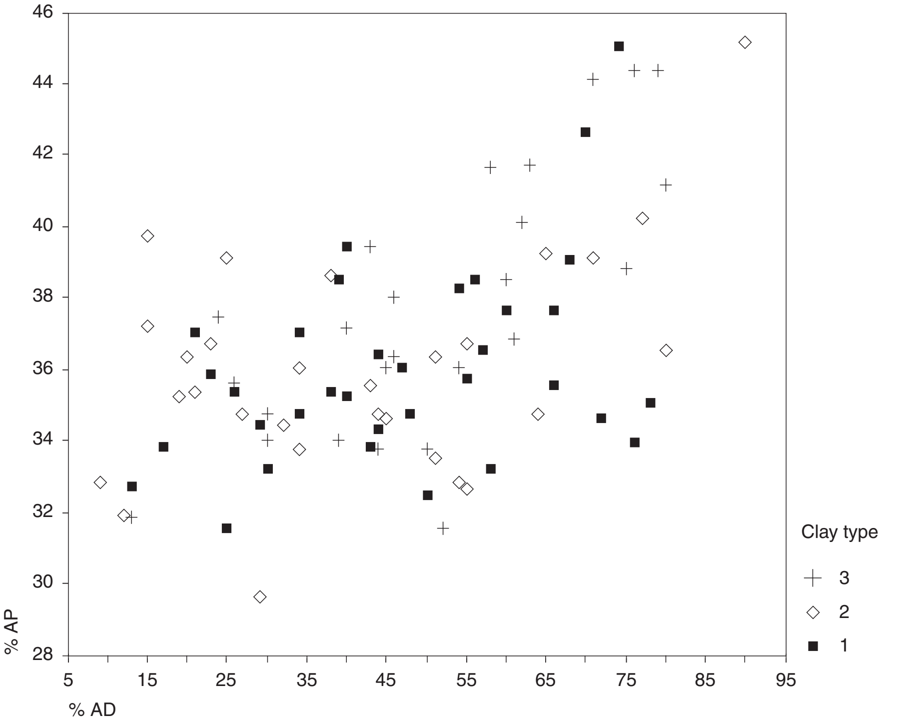

Fig. 7.1a The relation between the %AD of temper, the %AP and the type of clay.

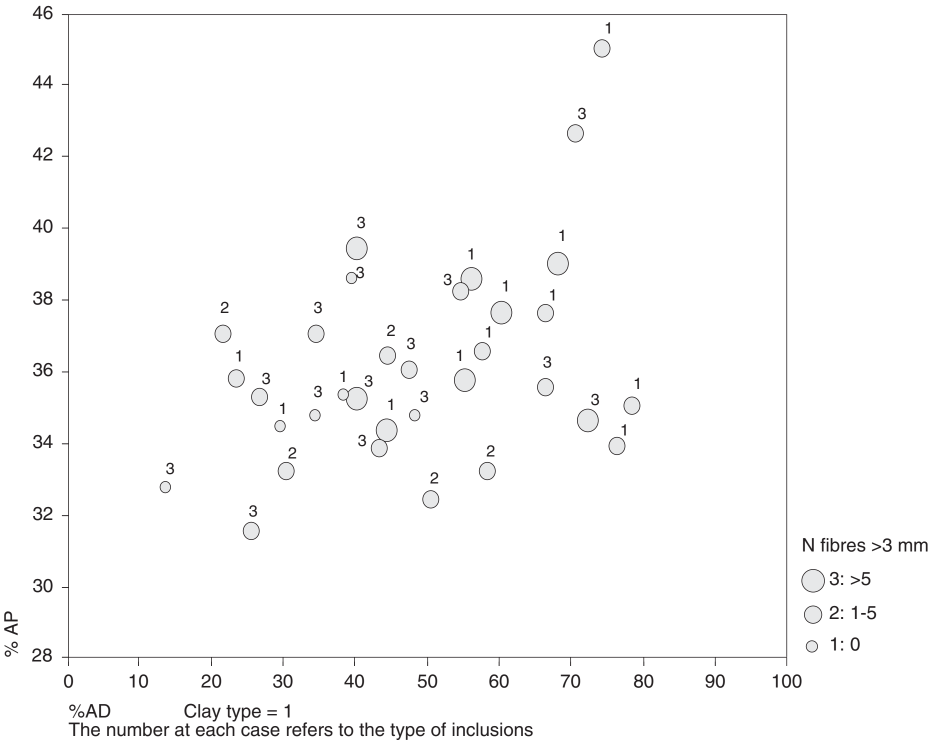

Fig. 7.1b The relations between the %AD and the %AP for vessels made of clay type 1, classified by the amount of coarse temper.

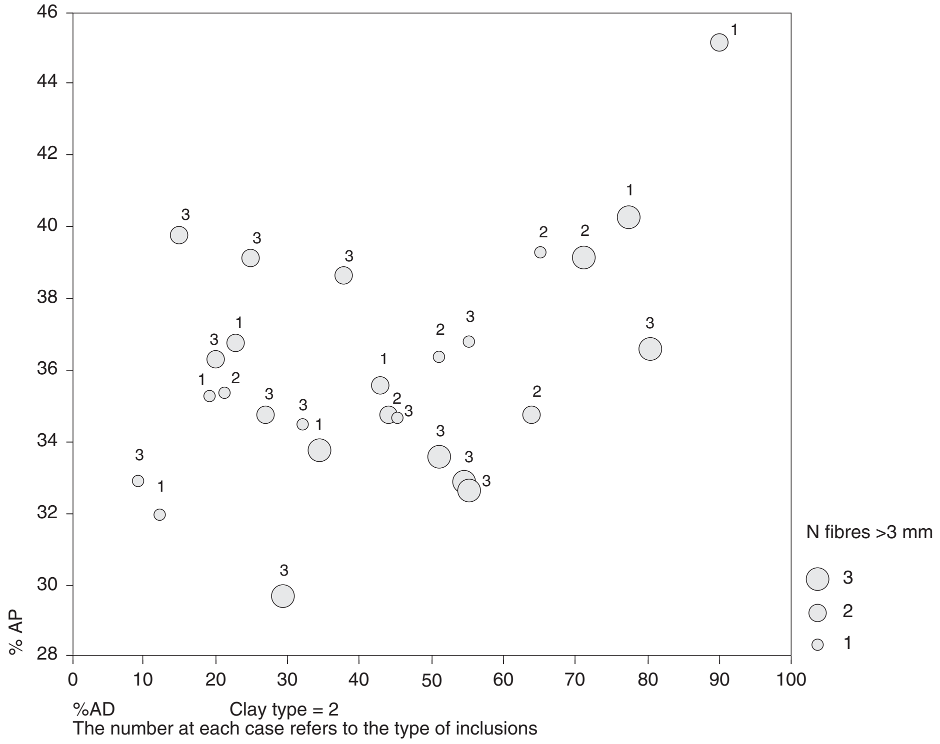

Fig. 7.1c as b, for vessels made of clay type 2.

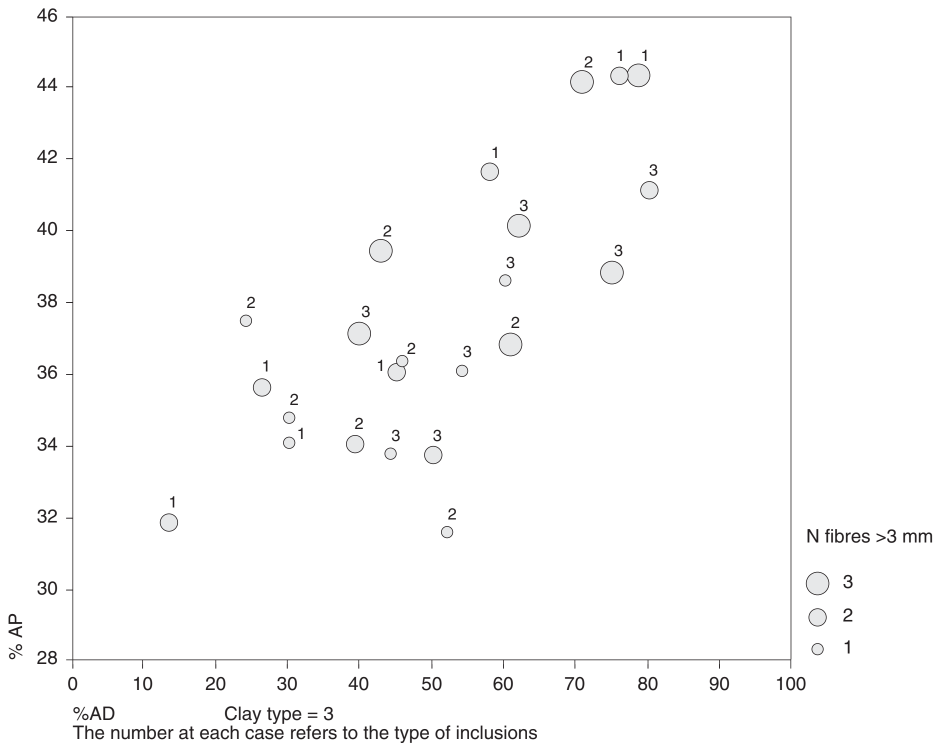

Fig. 7.1d as b, for vessels made of clay type 3.

Fig. 7.2 Uitgeest-Gr.D., sample 1. The relationships between classified fabric variables.

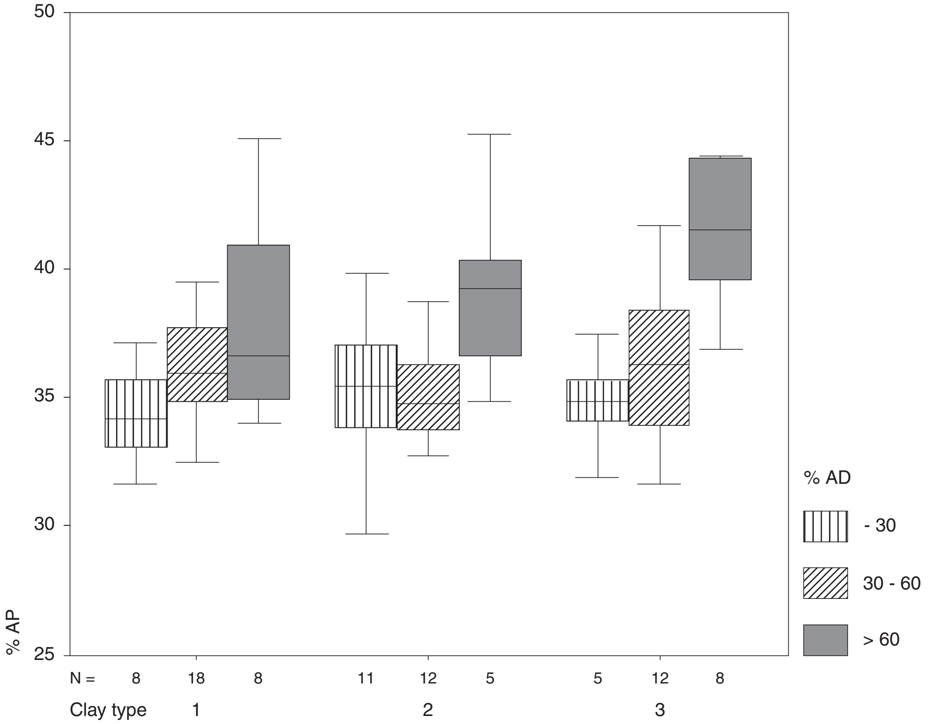

Fig. 7.2a The relation between the %AD and the variation in the %AP for clay type 1-3.

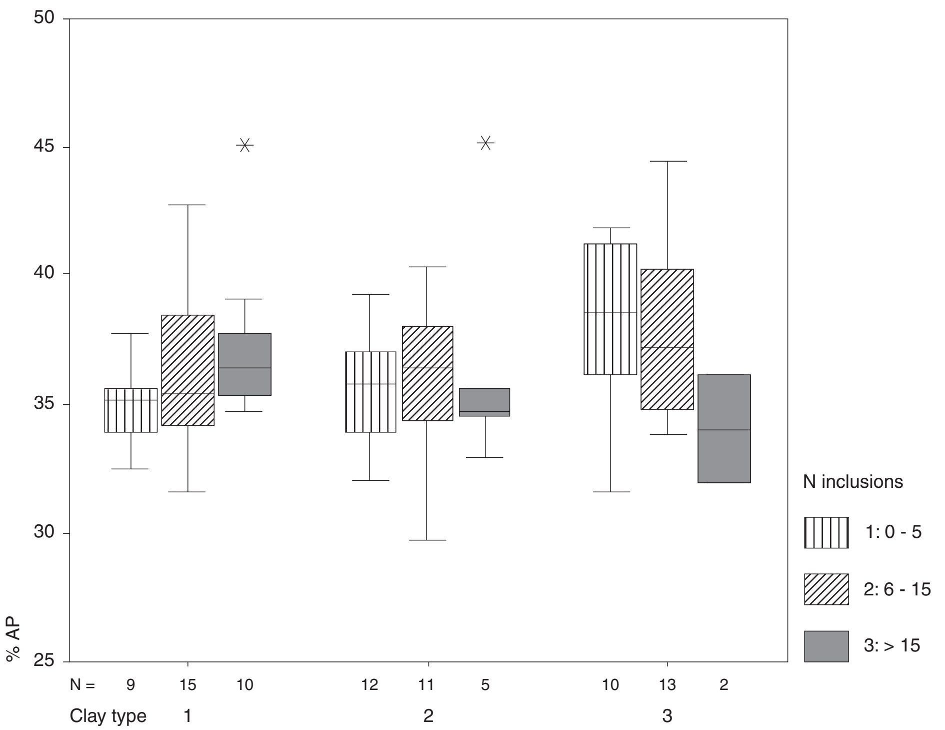

Fig. 7.2b The relation between the quantity of inclusions and the variation in the %AP for clay type 1-3.

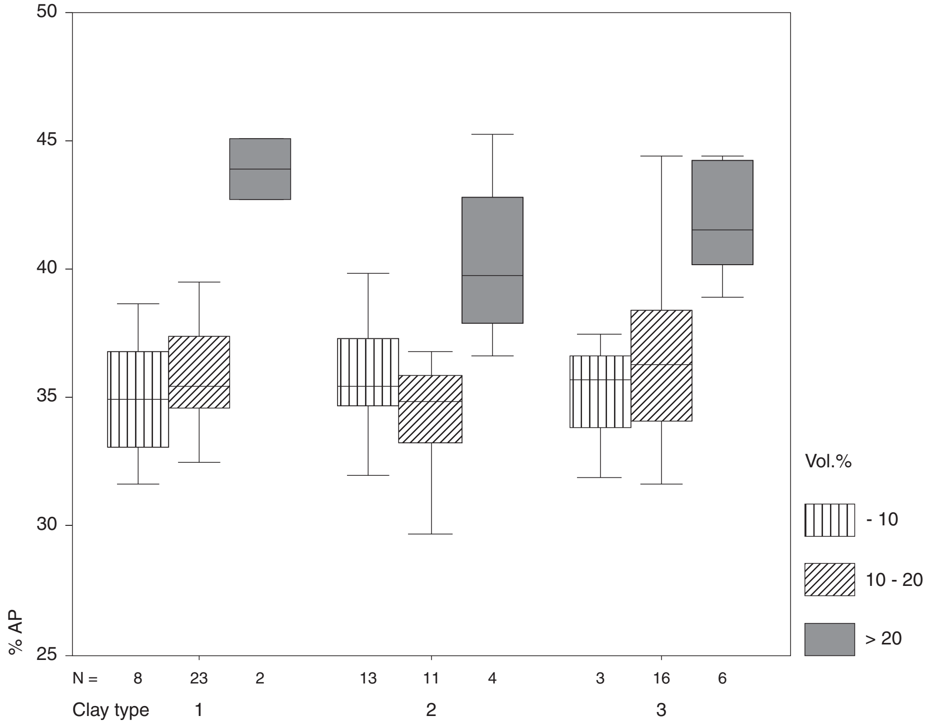

Fig. 7.2c The relation between the vol% of temper and the variation in the %AP for clay type 1-3.

Fig. 7.3 Schagen-M1. The relations between temper variables and clay types.

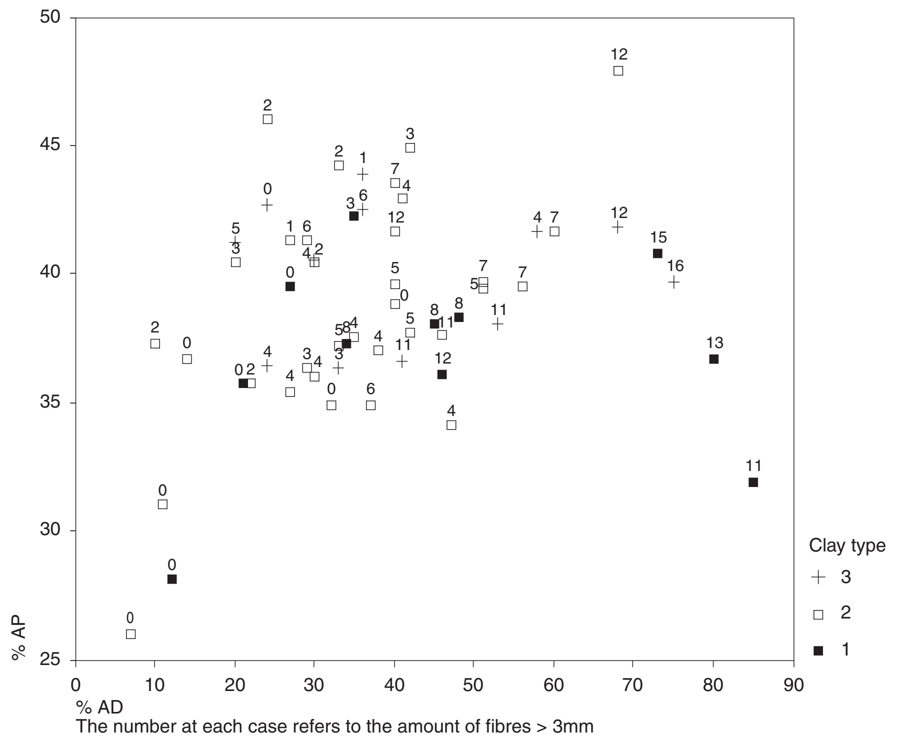

Fig. 7.3a The relation between the %AD of temper, the %AP and the type of clay.

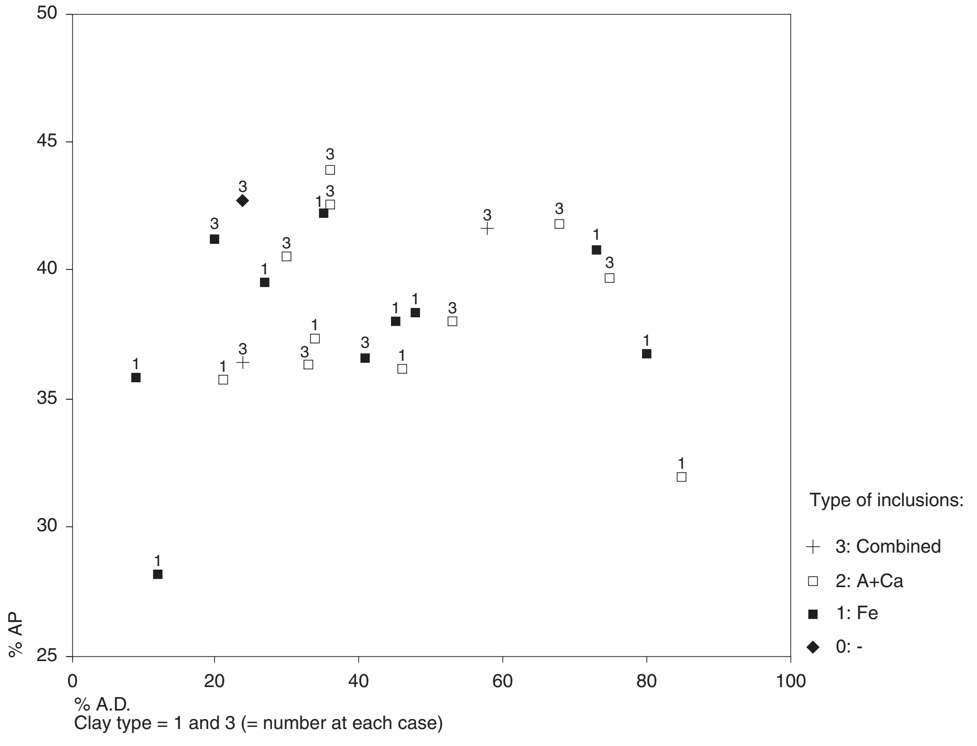

Fig. 7.3b The relation between the %AP and the %AD for vessels made of clay type 1 and 3, with the type of inclusions in the clay.

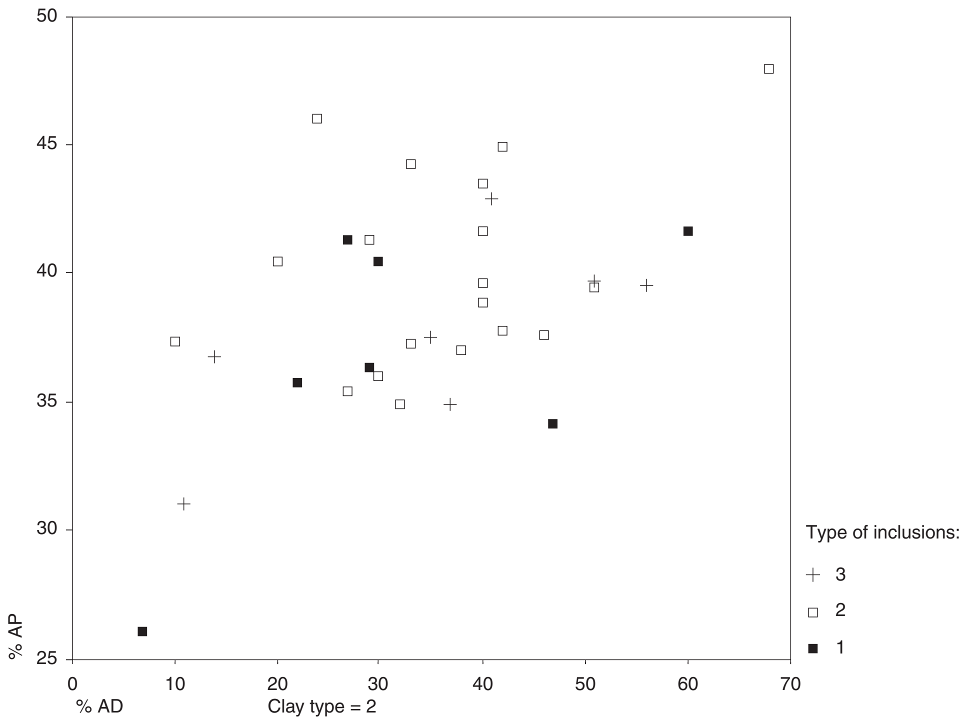

Fig. 7.3c as 3b, for vessels made of clay type 2.

Fig. 7.4 Schagen-M1. The relationships between classified fabric variables.

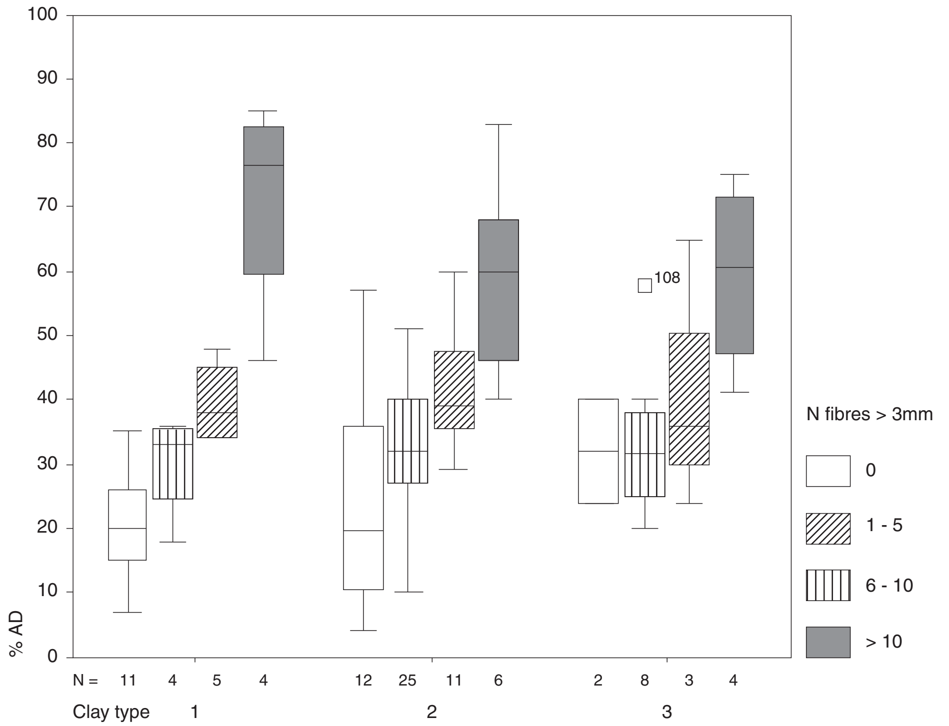

Fig. 7.4a The relation between the amount of coarse temper and the variation in the %AD for clay type 1-3.

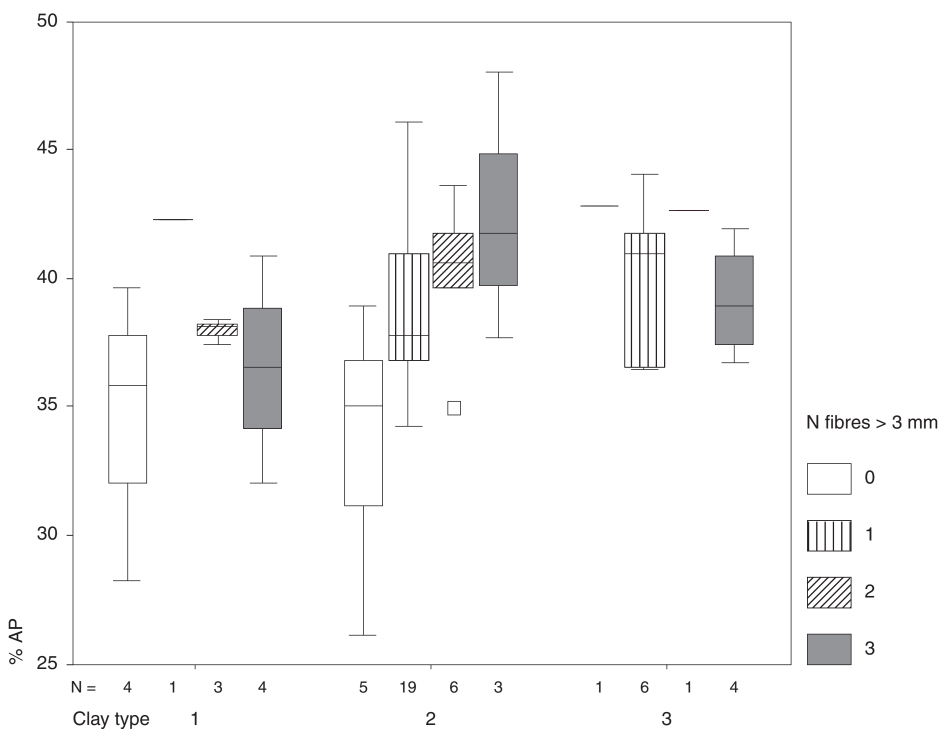

Fig. 7.4b The relation between the amount of coarse temper and the variation in the %AP for clay type 1-3.

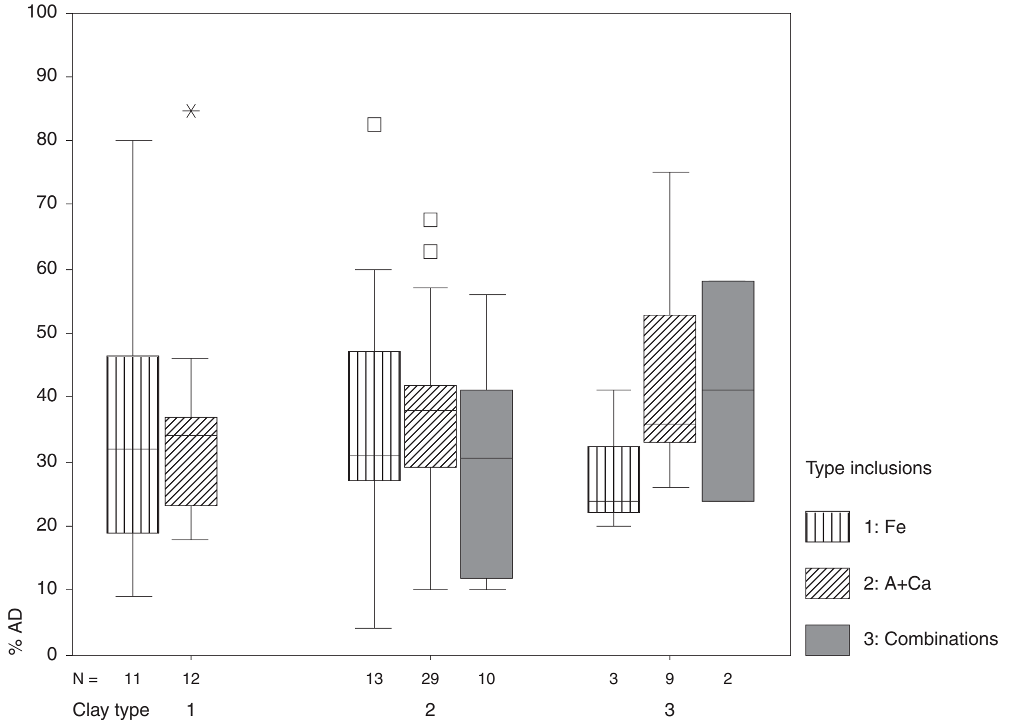

Fig. 7.4c The relation between the type of inclusions and the variation in the %AD for clay type 1-3.