Plasmic fabric analysis of glacial sediments using quantitative image analysis methods and GIS techniques
Zaniewski, K.

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
SUMMARY

The Method

This project was undertaken in an effort to streamline the process of identification and quantification of plasmic fabrics in glacial sediments. It was necessary since almost all previous research used qualitative means of plasmic fabric description making standardized comparisons nearly impossible.

To allow for this more quantitative approach it is necessary to first redefine plasmic fabric characteristics into a more computer friendly form. Previous plasmic fabric classifications relied in many ways on subjective criteria. A more exact objective definition is needed before image analysis procedures are to be implemented. Based on the solid foundation of earlier classifications a new set of diagnostic criteria was created. These new criteria required information regarding not just the plasmic fabric domains but additional information regarding skeleton grains and voids.

The new method requires the use of digital images as the source of raw data. Images should include plain light, cross-polarized and gypsum wedge views for maximum effectiveness. They must be co-registered (overlap exactly), a result best obtained through the use of a digital camera mounted on a petrological microscope. The use of photographic prints is not advised as their ‘overlap’ is unlikely to be exact.

Each image is split into its colour bands producing 3 new gray scale images representing light intensities in red, green and blue components of the original image. These images are then processed using a GIS technique called ‘multispectral image classification’. The choice of the algorithm is left up to the user but testing showed that the unsupervised classification methods are more applicable in the highly complex imagery associated with thin sections of glacial sediments. The final product of this image processing routine is a simplified ‘map’ showing the major types of material detected: skeleton grains, matrix and voids.

Contiguous areas of ‘skeleton’ pixels are grouped into discrete grains. Each grain is measured to establish its longest axis dimension. Using this information it is possible to create grain size distribution curves. Grains can also be selected based on their size.

A similar procedure is performed on identified void areas. This is necessary not just to establish the overall porosity of the sample but also to facilitate a size based selection. Size selection is needed to streamline the process of vosepic plasmic fabric identification by excluding very small voids.
The matrix is further divided into birefringent and non-birefringent elements. The birefringence is based on the combined brightness values from the red and green components of a cross-polarized image (Birefringent Intensity Value). The threshold value identifying birefringence is set at 250 BIV. Contiguous zones of birefringence represent individual plasma separation domains.

Each domain of plasmic fabric is evaluated for a series of attributes. These include size, selected shape characteristics, orientation and plasmic fabric strength (PFS). PFS value is a new concept created specifically for this method. The PFS value is a product of not only its average birefringence intensity (mean BIV for all the pixels included in the domain) but also its variance. The range of possible PFS values extends from 6.10 to 510.

All these characteristics are subsequently combined to effectively evaluate the type of plasmic fabric pattern observed in a tested image. Plasmic fabric patterns include: argillasepic, silasepic, insepic, masepic, bimasepic, omnisepic, vosepic, and skelsepic. The results also include grain size distribution data, plasmic fabric strength values for all the domains identified and the orientation values for sufficiently elongated domains.

The Results

The testing phase of the project involved application of the new method to a set of four thin sections. The results of this process were then compared with existing qualitative descriptions and interpretations of these sections. These were chosen primarily based on the quality and variety of the plasmic fabric patterns present. It was also important that the thin sections were previously described and used in actual studies. Of the four thin sections, the Moneydie sample was studied in greater detail as it included a variety of plasmic fabrics. The results showed many differences between qualitative and quantitative descriptions.

When evaluating the results for texture and sorting it became obvious that the visual descriptions substantially overestimated the sorting values. The image analysis method proved its value in accurately differentiating between textural classes of sand sized material but showed itself to be of limited value in the evaluation of material finer than silt and coarser than coarse sand. These drawbacks are however permissible since the real emphasis of the program is on the evaluation of plasmic fabric, while the textural information is for general impression purposes only and to aid in plasmic fabric diagnostics. For that purpose the method needs to be highly accurate only when separating between sand and silt sized skeleton grains.
Of the plasmic fabric types showing predominant orientation pattern, masepic appeared more frequently in objective results than was expected based on qualitative studies. Bi- and trimasepic patterns were however not found at all. This may be the result of optical illusion as a result of observing a highly complex visual environment. The lack of multidirectional fabric may also be explained by too stringent a set of diagnostic criteria selected for their identification.

Lattisepic plasmic fabric was similarly missing from objective results. This type of plasmic fabric may too be a case of wishful thinking and possibly optical illusion. It also important to point out that the rather strict definition of lattisepic plasmic fabric (both qualitative and quantitative definitions) is likely to result in very few identified examples of this type of fabric.

Skelsepic plasmic fabric was observed more frequently than in qualitative studies. The process of identification of skelsepic plasmic fabric may require further refinement in the future. One suggested modification includes the use of skeleton grain frequency information to estimate the accepted proportion of domains expected within the critical range of 25 µm of all the identified grains.

The method failed to measure and identify unistrial plasmic fabric. This limitation will have to be overcome in the future.

The most important objective of the thesis, which is to objectively evaluate plasmic fabric strength, was achieved. The technique allows evaluation of the plasmic strength as well as image anisotropism (frequency of plasmic fabric expressed as percentage of image area occupied by anisotropic plasma). Although some final refinement of the method will still be required it already forms a firm foundation for future micromorphological image analysis of glacial sediments.