Plasmic fabric analysis of glacial sediments using quantitative image analysis methods and GIS techniques
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FINAL REMARKS

Following the testing phase of this thesis (previous chapter) it became apparent that the visual observations differed substantially from the image analysis results. The significance of this development cannot be overstated. Plasmic fabric evidence is a significant part of almost all current micromorphological studies. If qualitative information is shown to be flawed for any reason, the entire series of genetic interpretations may be thrown into doubt. This is, of course, a worst case scenario. It is more likely that re-evaluation of the plasmic fabric data using image analysis will result in some re-definition of the established diagnostic criteria. The complexity of glacial sediments does not allow for identification based on any single diagnostic feature. Sediment type may be identified through the combination of microfeatures present, including plasmic fabric patterns. The new findings will therefore impact most severely on those studies in which sediment interpretations were based primarily on plasmic fabric arrangements.

The discrepancies between the qualitative and quantitative results must therefore be accounted for prior to any future application of the method. The reasons for incorrect qualitative fabric pattern identification may range from a subjective subconscious bias of the observer to an illusion based on specific arrangements of shapes within an image. This explanation presumes that the differences are entirely the result of flawed qualitative description. It is therefore also necessary to analyse the quantitative criteria used to identify the plasmic fabric patterns (Chapter 3). It may be that these values were too stringent, minimizing the frequency with which certain fabric patterns were identified. Finalizing the set of diagnostic criteria is necessary before any further work of interpretation is initiated. To do otherwise is to invite the possibility of future reinterpretations of the objective results, throwing into doubt subsequent conclusions.

Another issue to be considered is an alternate approach of plasmic fabric analysis. Current classification methods (Brewer, 1976; Bullock et al., 1985) define plasmic fabric patterns based purely on their appearance. Fabric is identified according to the shape, orientation, size and frequency of the domains and then given a label which fits the patterns best. Subsequently, plasmic fabric identification is very rigid - hardly applicable when the development of plasmic fabric is studied - a process which is essentially gradual in nature. Based on the results obtained through the image analysis application (previous chapter) plasmic fabric tends to appear as a continuum of shapes and patterns of distribution. It is my personal opinion that descriptive classification methods are too inflexible to suit the needs of objective analysis in the future. A new method of plasmic fabric description and quantification is...
required. It should describe plasmic fabric in terms most suited towards quantification, such as anisotropism frequency, area or preferred domain orientation. Descriptive labels could still be used (as in FitzPatrick 1984; 1993) but these would only be used as general representative terms when an estimate or a rough description is required. Actual analysis and interpretation of data should be limited to the measured numerical values.

This last point brings us to the most important aspect of any future research. Having the capacity to accurately gauge anisotropic frequency, preferred plasmic fabric orientation and birefringent strength provides a way of accurately quantifying plasmic fabric. Plasmic fabric reflects the sedimentary and/or tectonic history of the sample but, in itself, only represents a snapshot of an ongoing process. Once impregnated, the sample is permanently preserved and the diagenetic processes affecting the sediment are halted. The resulting image, including plasmic fabric patterns, represents the accumulated effect of deposition and subsequent diagenesis. Each image is a complex digital record of the complex time and space interaction between sediment and its environment. From the point of view of glacial sedimentology, to identify the processes and conditions under which the sediment was deposited and later deformed is to learn its (depositional) history. These thin section snapshots of glacial history are now frequently used to complement qualitative interpretation of glacial sedimentary history. The use of quantified plasmic fabric information promises to make such interpretations much more accurate. For this to happen, a concerted effort must be undertaken to measure the effects of stress on plasmic fabric development. Although many such research projects have been completed (Clark, 1970; Foster and De, 1971; Dalrymple and Jim, 1984; Maltman, 1987; Hiemstra and Rijsdijk, in press) their results have been almost completely qualitative. Image analysis provides much more precise and absolute results.

If a series of tests were to be performed under controlled condition it may be possible to better understand the relationship between stresses, deforming sediments and their associated plasmic fabric patterns. Initial emphasis should include studies of the relationship between stresses, changing moisture content, clay mineralogy, texture (clay content) and carbonate material content. Carbonate material should be considered because of its known optical anisotropism masking qualities.

The results sought may be obtained in a number of ways. Preferable approach should involve existing thin sections with accurately measured characteristics such as texture or carbonates content. Image analysis can then be used to measure plasmic fabric strength and anisotropism frequency. The study of the relationship between moisture, stresses and plasmic fabric will require a more fundamental approach involving creation of new thin sections.
A series of thin sections produced from the same material (controlled clay content, no carbonates) but undergoing varying degrees of applied stress (unidirectional) and shifting moisture levels would then be created. These would be image-analysed to measure plasmic fabric strength and anisotropism frequency.

Data thus obtained could be used to produce a series of plots showing the relationship between each of the variables and anisotropic fabric strength/frequency.

Accounting for the effects of the tested variables will allow us to see the effect of glacially induced stresses on plasmic fabric patterns and frequencies much more clearly. The results will go a long way towards an accurate identification of glacial sediments and their depositional history.

This thesis and the methodology described therein, must be considered as the first step of the long way towards comprehensive glacial sediment identification. Although complex, the methodology described covers only the most rudimentary aspects of plasmic fabric. Its full implementation should only be attempted once some of the major concerns posed above have been addressed. The techniques used are fundamentally sound, allowing for precise and accurate plasmic fabric measurements. In addition, the logic and the rules described can be applied in image analysis of other sedimentary features if required. Once combined with accurate supplementary data, image analysis of thin section images will no doubt play a fundamental role in any future sedimentary studies.