Fully-automated counting for fission track dating and thermochronology

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We report on new image analysis techniques that, for the first time, provide a practical solution to the problem of fully automated counting of fission-tracks in natural minerals. This has been one of the most long-sought after goals of fission track dating but has so far remained beyond reach. Specific challenges to be overcome are the discrimination of fission tracks from non-track defects, polishing scratches etc, resolving multiple track overlaps, and reliable identification of small tracks amongst a similarly sized background of surface defects, fluid inclusions etc. Most previous attempts at automated image analysis have failed in one or more of these tasks.

The central component of our system is called *'Coincidence Mapping^{TM}'* and utilises two images of the same tracks obtained in transmitted and reflected light. The complementary nature of the information in these two images allows a powerful discrimination of true fission-tracks from most non-track features. The much higher spatial resolution of the reflected light image allows the resolution of most track overlaps in the transmited light image. The discrimination is achieved by segmenting the two initial images using a custom-developed thresholding routine and extracting the intersection of the two binary images using a Boolean AND operation. The analysis is extremely efficient and takes only a few seconds to complete the processing of images that contain up to many hundreds of tracks.

The method is extremely effective in resolving multiple track overlaps and in discriminating tracks from various spurious image features. Coincidence mapping has successfully counted very high track densities in muscovite (up to 5×10^7 cm^{-2}), well beyond the limit for manual counting in transmitted light. The technique also works remarkably well in the essential, but more challenging, task of counting spontaneous fission-tracks in natural apatite crystals. Error rates determined so far are about the same or better than those achieved by a human operator under normal counting conditions.

Automated counting should significantly increase the speed of analysis and improve data quality in fission track dating through better counting statistics, increased objectivity, and measurement of additional track description parameters that are not currently determined.