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SLIDING TABLE FOR RAPID EVALUATION OF FISSION-TRACK RECORDS AND ITS APPLICATION

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Abstract

The paper describes the construction and use of a sliding table for the rapid evaluation of fission-track records and the grain-for-grain matching with the relevant polished thin sections. Instead of the usual detector-and-ore sandwich technique, the fission-track record and the polished thin section are placed side by side into a sliding frame, aligned and switched alternately into the field of view. The unobscured fission-track record allows a much better study of the distribution of radioactive elements and affords rapid semiquantitative measurements of their concentration.

Keywords: fission-track, rapid evaluation, sliding table, uranium ore.

Sommaire

On décrit la construction et l'utilisation d'une table glissante conçue pour l'évaluation rapide des fiches de traces de fission et leur corrélation grain par grain avec les lames minces polies contiguës. Au lieu d'employer la technique de superposition du détecteur et du minerai, la fiche et la lame mince sont placées côte à côte dans un cadre que l'on glisse tour à tour dans le champ de vision d'un microscope. L'examen de la fiche sans obstruction permet une bien meilleure étude de la distribution des éléments radioactifs et une évaluation semi-quantitative rapide de leur concentration.

(Traduit par la Rédaction)

Mots-clés: trace de fission, évaluation rapide, table glissante, minerai d'uranium.

Introduction

The mineralogical study of disseminated uranium ores often involves localization of uranium-bearing minerals by means of the induced fission-track method of autoradiography in its various modifications. An inevitable but time-consuming step is the visual correlation of features observed in the radiation record with mineral grains in the original polished sample. The comparison is usually done by studying detector-and-ore (rock) sandwiches. This procedure is slow and can be very tedious if the polished thin sections examined contain abundant mafic minerals or are clouded with alteration products, or if the radioactive minerals occur as tiny grains or parts of complex fine-grained aggregates.

The Alternative Technique

In a mineralogical study of the complex, disseminated uranium ore found at Kvanefjeld, in the Ilímaussaq massif, southern Greenland (Makovicky *et al.* 1980), a considerable number of Lexan fission-track records were to be examined and compared with the relevant polished thin sections prepared from drill cores. Several distinct U-bearing mineral species were expected in unknown quantities, and the ore-bearing rocks displayed all the unfavorable features mentioned above.

A sliding table attached to the mechanical stage of a microscope was devised for quick comparison of Lexan fission-track records with original polished thin sections (Figs. 1, 2). The Lexan slide, with the track side down, and the thin section are side by side in the sliding frame of this table. They are aligned in their respective windows. Sliding the frame back and forth, the mineral grain and its fission-track record will be brought into the same position in the field of view. Exact alignment of the two images is performed for the first radioactive grain examined by means of terminal screws on the body of the table. It is then valid for all the grains brought into the field of view by means of the mechanical stage.

This procedure allows quick and exact correlation between the radiation record and the original section. Both the record and the rock section remain unobscured, so that even feeble uranium contents (*e.g.*, dispersal of U along microfissures), grain zonation in U-bearing minerals, tiny inclusions and products of alteration can be easily recognized and readily correlated. Finally, fission-track counting or other, more efficient methods for the estimation of U contents (see below) can be performed without repeatedly displacing and replacing the damage-prone Lexan detector away from and back onto the

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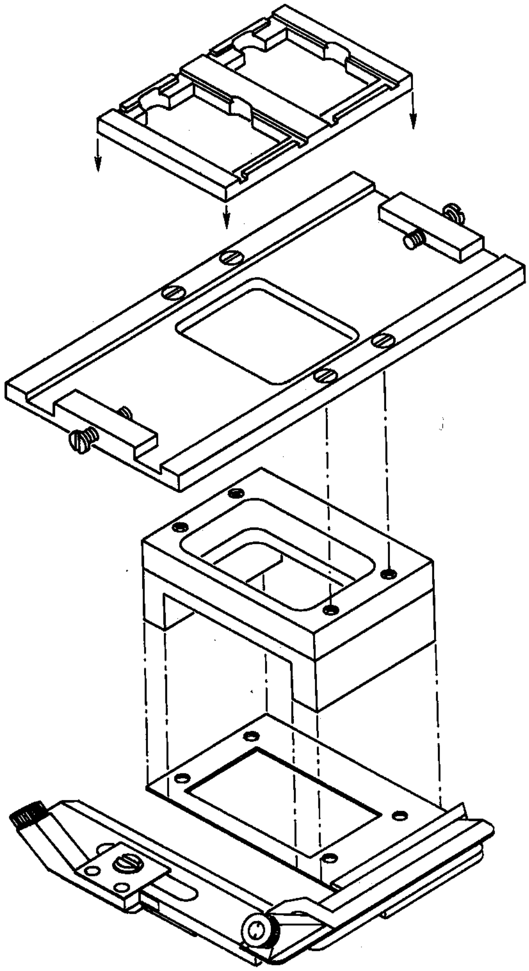

FIG. 1. Exploded drawing of the sliding table for evaluation of fission-track records, mounted on a commercial mechanical stage.

rock section. The same arrangement can be used for autoradiographic records, β-sensitive emulsions and even for the topochemical records obtained from the surfaces of polished thin sections by means of localized chemical or electrochemical reactions. The present method differs in many respects from the dual-microscope comparator for fission-track studies devised by Dooley *et al.* (1970). It does not require simultaneous use of two microscopes, which has become impossible with the advent of modern, heavy research apparatus.

TECHNICAL DATA

For cost-saving purposes, the sliding table was mounted onto a commercial mechanical stage. Although the dimensions will vary with the mechanical stage and microscope used, numerical data compatible with the Leitz stage and microscope are given for information.

The table is mounted with its support on a copper plate (50 × 82 mm, 8 mm of the latter being under the arm of the stage) that is attached by screws to the arm of the mechanical stage in place of the original "pincers". The copper plate slides over the surface of the rotatable microscope stage without damaging it when the mechanical stage screws are operated; it carries the whole weight of the device. To keep the sliding table clear of the screws of the mechanical stage, an aluminum support (70 × 50 mm, 28 mm high) is mounted on the copper plate, 5 mm away from the stage arm (Figs. 1, 2). The elevated position of the table prevents conoscopic optical observations on mineral grains. However, this procedure is of little importance for the often-metamict radioactive minerals, and is easily performed subsequently in those rare instances where required.

The support is hollowed out (and the copper plate pierced) by a light shaft 30 × 50 mm for transmitted-light microscopy; this aids the weight reduction (Fig. 1). The long sides of the support are also pierced, leaving 10-mm-thick solid walls on the shorter, 50-mm-long sides of the support. The light shaft is placed asymmetrically in the support, leaving only 5-mm-thick (pierced) walls on the long side oriented toward the arm of the mechanical stage. It is central with respect to the optic axis when the stage is in its central position.

The top plate of the sliding table (Figs. 1, 2) is machined out of a brass plate, 7 mm thick, 70 × 145 mm wide. The broad trough for the sliding frame has been machined out and planed down to the remaining plate-thickness of 3 mm. The frame-guiding ridges along the sides protrude 2 mm above the trough; the terminal ones that house the adjustment screws preserve the original thickness of the plate. The table plate is positioned symmetrically with respect to the optic axis of the microscope, *i.e.*, the centre of the 50-mm-long side of the support is 78 mm from the end of the table plate on the side extending above the screw of the mechanical stage. The terminal edges allow 125 mm of free movement for the sliding frame. This value is reduced by several mm by the terminal screws according to the fine adjustment needed. This light shaft of the support continues through the brass plate (Fig. 1).

The sliding double-window frame (Figs. 1, 2) is machined out of brass, 78 × 52 mm in size and 5 mm thick. The two openings, each 28 × 48 mm, are designed for the usual size of microscope object glass and are 10 mm apart. In order to provide support under both the section and the Lexan slide, the openings are reduced to only 26 × 40 mm. The depth

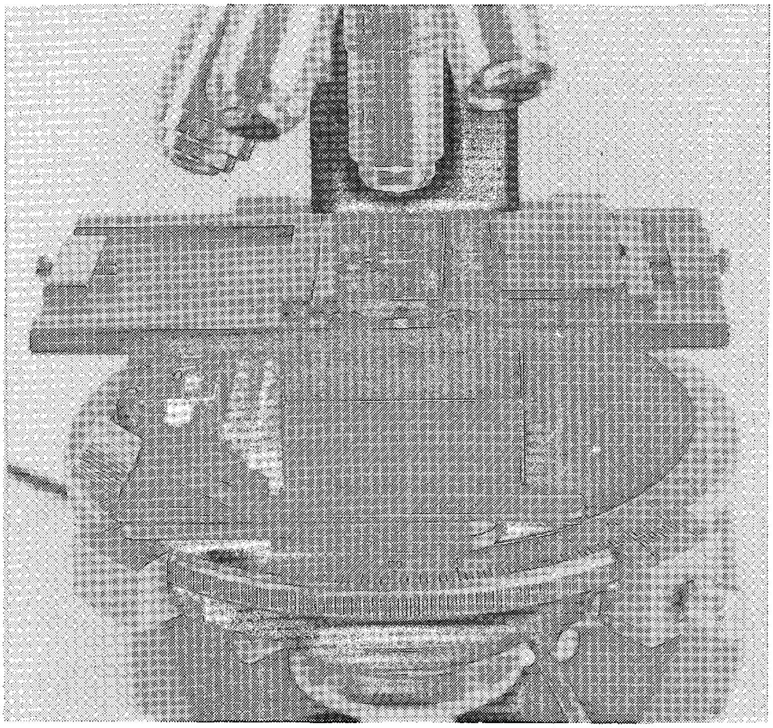

FIG. 2. Sliding table for evaluation of fission-track records, mounted on a microscope rotation stage for use. Position for the examination of Lexan slides. The right-hand window is covered by the polished thin section from which the induced fission tracks have been recorded.

of the openings for the slide and section accommodation differs: the features to be studied are situated on the top side of the polished thin section, but they are situated on the lower side of the Lexan slide. Preferably, they should lie in the same focal plane. Both the section and the slide were aligned along two of their edges prior to the exposure in the reactor and kept aligned by taping the section and slide together. Now these edges will be pressed against the corresponding edges of the two windows in the sliding frame. This position can (if necessary) be stabilized by gently inserting light plastic (or rubber) wedges into the notches in the opposite edges of these two windows (Fig. 1). The sliding frame rests on the table plate by its own weight only and can be easily removed and replaced for each exchange of sections and fission-track slides. Slight lubrication of sliding surfaces proved to be sufficient.

In spite of its simplicity, the sliding table is a precision instrument, requiring a properly equipped mechanical workshop. The present instrument has been functioning for several years without signs of wear on either the table or the mechanical stage.

RAPID ESTIMATION OF URANIUM CONCENTRATIONS

One application facilitated by the present arrangement is a rapid method of estimating uranium concentration in the observed mineral grains. This would be impossible in the sandwich arrangement or could only be performed summarily on the Lexan slide when the sandwich has been separated.

The uranium content of the ore minerals in the examined material (primarily steenstrupine, a complex silicophosphate) typically varies from several ppm to over 1 wt.%. In many cases it varies considerably, even for distinct grains of the same mineral in one polished thin section and for distinct zones of individual grains. The total U-content of the studied ore samples was estimated by other methods.

In this situation, exact counting of fission tracks was of little value compared to the amount of man-hours required. Instead, a rapid method was adopted that gave statistically significant data for mineral beneficiation with an acceptable investment in time. Two glass slides with six polished standard glass buttons each, with uranium contents graded up to 1 wt.% U_3O_8, were irradiated with each batch of rock section – Lexan sandwiches. Then, for all mineral grains sufficiently large in comparison with the penetration length for a particle, the total density of fission tracks (similar to the "blackening" of photographic emulsions) was compared with the fission-track densities from the standard glasses, using interpolation where necessary. The results were checked by microprobe measurements and were found adequate for the given situation and the purpose of the study. With the densities of U-containing glass and of metamict steenstrupine sufficiently close to each other, no corrections for density-related effects were necessary. Only where the concentration of U exceeds 1 wt.% U_3O_8, *e.g.*, in relatively rare grains of uranothorite that produced total "blackening" of the Lexan detector, additional electron-microprobe analyses were needed. With this technique, provided the densities of the standard glass and of the mineral examined are similar, evaluations can be made in ppm U_3O_8, avoiding all intermediate calibrations. The comparison is done by sliding the Lexan record of the standard glasses in an overturned position over the examined Lexan slide until the track densities of the standard match or bracket those of the ore examined.

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References

Dooley, J.R., Jr., Taylor, R.B. & Jurceka, F.J. (1970): Dual microscope comparator for fission-track studies. *Rev. Sci. Instr.* **41**, 887-888.

Makovicky, M., Makovicky, E., Nielsen, B.L., Karup-Møller, S. & Sørensen, E. (1980): Mineralogical, radiographic and uranium leaching studies of the uranium ore from Kvanefjeld, Ilímaussaq Complex, South Greenland. *Risø Nat. Lab. Rep.* **R-416**.

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