

# 2DTraC: An Excel add-in for 2D spatial transformations with applications in microscopy and microanalysis<sup>☆</sup>

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## Abstract

A Microsoft Excel add-in has been developed to aid the relocation of analysis points on petrographical samples between analytical runs on different microscopes and instruments. The general procedure is as follows. Two readily identifiable reference points are defined on the sample. During the first analytical run, the positions of these reference points and of any features of interest are recorded using the co-ordinate system of this instrument. During a subsequent run, which may be on a different instrument with a different co-ordinate system, the positions of the reference points are recorded. The add-in then uses the reference point positions to calculate a set of transformations that maps the co-ordinate system of the first instrument into that of the second. These transformations are then applied to the co-ordinates of the features of interest to calculate their expected positions on the second instrument.

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## 1. Introduction

Petrographers, mineralogists and geochemists commonly need to relocate analysis points or features of interest when samples are transferred between microscopes and other analytical instruments (especially microprobes). Two approaches, traditionally adopted for this purpose are to

(1) mark features of interest on the sample surface using a diamond-tipped or ink pen, or

(2) acquire an image of the entire sample that is used as a “map” of the sample upon which features of interest are marked.

Both these approaches are relatively time consuming, and in the case of (1) samples are actually damaged in the process. Furthermore, point relocation is often hampered by the fact that the same feature may have a very different appearance when imaged by different instruments (e.g. optical versus electron microscope images). This may be compounded by inversion and/or rotation of images, the necessity to add conductive coatings, differences in magnification factors and/or restricted fields of view on some instruments.

Because of these problems, a method of feature relocation that is not heavily reliant upon an image of the sample is desirable and, as an alternative, the  $X$ – $Y$  co-ordinates of features of interest could be used.

<sup>☆</sup>Code available at: <http://www.iamg.org/CGEditor/index.htm>.

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However, whilst many modern instruments have digitally controlled stages capable of sample positioning to micrometre levels of precision, it is often practically impossible to reload the sample in the same position/orientation on subsequent runs, meaning that features can not be directly located using co-ordinates measured from earlier runs. Furthermore, when undertaking analyses using more than one instrument, it is usually the case that the different instruments have different co-ordinate systems with different positions of the origin relative to the sample or imaged area, and/or different configurations of  $X$ – $Y$  co-ordinate arrays, which combine to make transfer of co-ordinates between instruments difficult.

Potts et al. (1995) used a digital camera or scanner to capture an image of the entire sample. The co-ordinates of the pixels corresponding to the features of interest were mapped to instrument co-ordinates by specifying the mirror transformations, and calculating the rotational and scaling transformations required to convert between the pixel co-ordinates of the image and the co-ordinate system of the instrument. The precision of the system described by Potts et al. (1995) was largely limited by the pixel-to-pixel resolution of the digital image of the entire sample, which was then of the order of 40–60  $\mu\text{m}$  (although modern, widely available desktop scanners capable of 2400 dpi imaging would nominally reduce this to ca. 10  $\mu\text{m}$ ). However, this system requires that the features of interest are readily identifiable in the scanned image of the sample.

This paper describes “2DTraC” (2-Dimensional Transformation Calculator; Bouch et al., 2002), which was developed to convert co-ordinates between the co-ordinate systems of different microscopes and micro-analytical instruments and can significantly reduce the amount of time required to relocate features as samples are transferred between instruments. The methodology applied is similar to that of Potts et al. (1995), however, the need to acquire an image of the whole sample, upon which the features of interest can be resolved, is removed.

## 2. System requirements and installation

The add-in requires a PC running Microsoft Windows NT/95 and Excel '97 or later versions. The file “2DTraC.xla” contains the functions used to calculate and apply the transformations and is supported by a template (‘2DTraC.xlt’). The add-in is installed by copying both files to a suitable location on the host computer (both must reside in the same directory), and either using the Excel Tools → Add-Ins... menu to make the add-in available each time Excel is opened, or by opening 2DTraC.xla for “one-off” usage. When the add-in is loaded, a new sub-menu “2DTraC” is added to the Excel ‘Tools’ menu (Fig. 1).

## 3. Reference point definition

The add-in uses two reference points (A and B) on the sample to calculate the transformations, and the precision/accuracy of the transformations is influenced by the precision/accuracy by which these positions can be measured. Therefore, the aim is to use or create a feature in a predictable position on the sample surface that is readily identifiable at low magnification but has sufficient internal detail to allow relatively unambiguous and precise relocation by different operators irrespective of the analytical instrument being used. In order to minimise the impact of any imprecision in the determination of the reference point positions, it is advantageous if they are widely spaced, diagonally across the sample surface. Two further considerations are that certain instruments have sample holders that prevent features at the edge of the sample (such as the edge or corners of the sample itself) being used as reference points, and certain instruments only image the upper surface of the sample. Therefore, for our purposes the reference point(s) should be away from the edge and on the upper surface of the sample.

A simple strategy is to mark ink crosses near the top-right and bottom-left corners of samples, and to define the reference points as the “top-right” intersections of the crossbeams (Fig. 2). With this strategy, on a given run using our instruments, measurement of reference point co-ordinates are typically repeatable to within 10  $\mu\text{m}$ . A “way-up” for the sample was defined by adding a dot to the bottom-left marking (Fig. 2). A third reference point (C, positioned wherever convenient on the sample) can be added to check whether transformations have been calculated correctly. A similar approach was suggested by Potts et al. (1995), who used

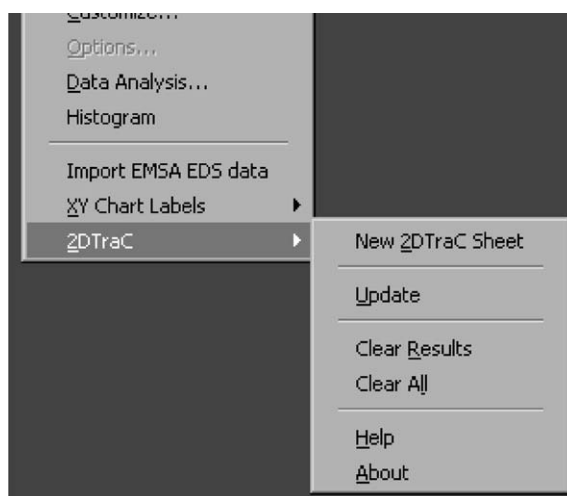


Fig. 1. Summary of options available on 2DTraC menu (on Excel Tools menu).

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