NOTE ON SERIAL SECTIONING OF FOSSIL SPECIMEN BY WHEEL-SAW CUTTER

by

Susumu HONJO, Nachio MINOURA, Sumio KUMANO and Dong Yong CHOI

(with 3 Text-figures and 1 plate)

(Contributions from the Department of Geology and Mineralogy, Faculty of Science, Hokkaido University, No. 1090)

The serial section method is one of the most useful techniques for studying organisms in the biological sciences. Although the texture in fossils is sometimes well preserved, it is almost impossible to apply the techniques used on living organisms to petrified organisms.

There are two methods, excluding radiographic technique to observe the internal structure of opaque fossils in three dimensions. The first is to cut a fossil in successive manner and make thin section preparation from each chip of samples, then reconstruct the three dimensional image of internal structure of the sample. The second is to grind down the fossils from an end and obtain a profile, and produce peel replica from the surface. Then prepare the second peel from the next profile which are ground parallel to the former one. By repeating this practice, entire sample will be converted into a number of peels.

The peel method has some advantages when small interval between sections is required. By using micro-peel technique (HONJO, 1963), very small interval between two adjacent profile, such as 10 microns or less, can be obtaind. The resolution in each peel is as high as being beyond the optical limit of magnification. Electron microscopy can be applied on those peel replica if desired. However, a peel has no optical significance what so ever; they are nothing but a record of relief on a profile which is produced by etching in an acid or chelating solution. The sample itself is disappeared after grinding through the length of specimen.

Needless to say, it is always best to work with the real specimen. Serial thin-section therefore reserves great advantage on peel method. However, the distance between two adjacent sections are difficult to make it being less than 5 mm by the ordinary method.

Regular stainless-steel rock-saw wheel is approximatly 0.8 mm in thickness. The saw gap is usually more than 2 mm because it is broaden by the vibration; at least 2 mm width of specimen will be lost by sawing. The surface of sawed chips is usually covered by coarse saw-marks, therefore, one surface of the chip is subject to grind to even them before being mounted on a slide-glass. This costs some 0.5 mm thickness of sample. The percussion effect by the wheel-saw edge on specimen requires more mechanical strength for a chip. At least few millimeters of sample should be left between two saw-gaps.

As is obvious from the above consideration, the serial sectioning technique of petrified material by an ordinary rock saw requires few points of improvement; 1) thinner wheel blade, 2) minimize the mechanical vibration, 3) keep forwarding speed of wheel constant, 4) smooth wheel edge to obtain better finish on a chip surface, and 5) more precise cross traverse mechanism for shifting a specimen.

There are two types of whell-saw have been used in paleontology. They are inner-rim and outer-rim wheel-saws (Fig. 1). The blade edge of inner-rim wheel-

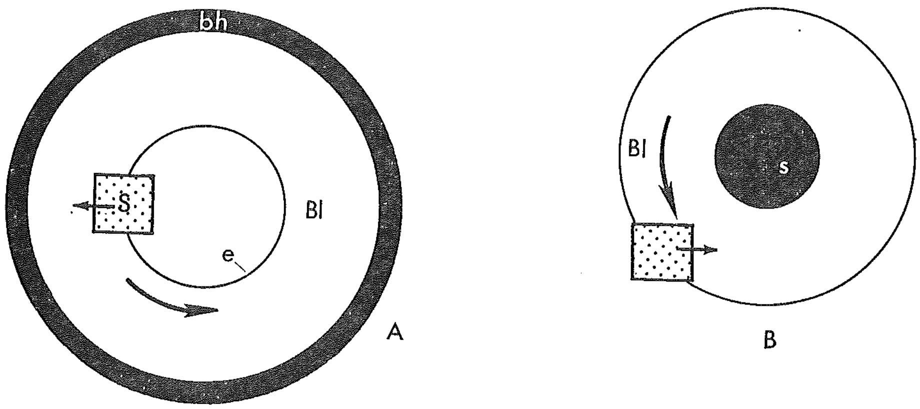

Fig. 1
A. An inner-rim type wheel blade (Bl) has an inner edge (e). A very thin blade (Bl) of special alloy is holded in the rigid blade holder (bh).
B. The fanction of a regular outer-rim type wheel blade.

saw is kept in tension by centrifugal force, therefore the wheel blade can be made significantly thin. The speed of rotation is much faster and this avoids vibration. Contrally, outer-rim wheel-saw is hard to make thinner because the wheel is not able to stand outward force as well as the strong percussion on the edge when it is forwarded onto a petrified specimen.

Cutbull, Sedgwick Museum (1968, personal communication) has been successful to apply an inner-rim type crystal cutter with extra-thin blade (titanium alloy) for the serial sectioning of fusulinid specimens. The sectioning interval is less than 100 micorns and an obtained chips are smooth enough to be ready to mount on slide glass. The blade thickness is 150 microns and saw-gap is ignorable. Chips as thin as 100 microns are kept safely on the neck. As a result, approximately

200 microns of interval can be obtained by this equipment at an optimum condition.

The inner-rim type cutter seems to be the best for serial sectioning purpose. However, this type of instrument is generally quite expensive and usually requirs delicate operation. The size of the sample to be worked is rather limitted.

We have built an outer-rim thin-blade wheel-saw (based on the model H35A, a product of Heiwa Kogyo Shyoji Co., Ltd, Tokyo) as the " second to the best choice " for fossil coral study. The blade is 300 microns in thickness, epoxy-based 800 mesh abressive disk with 15 cm diameter. The disk contiains several weight percent of fine alluminum powder to encourage the radiation of built-in heat. The blade speed is approximately 3,000 R. P. M.

The longitudinal slide of specimen is driven by an oil-pressure operated lead screw. Forwarding speed of the specimen holder against blade is approximately 5 mm/min. for regular epoxy embedded coral samples. The cross traverse is measured on a large micrometer gauge. The minimum traverse is 10 microns to

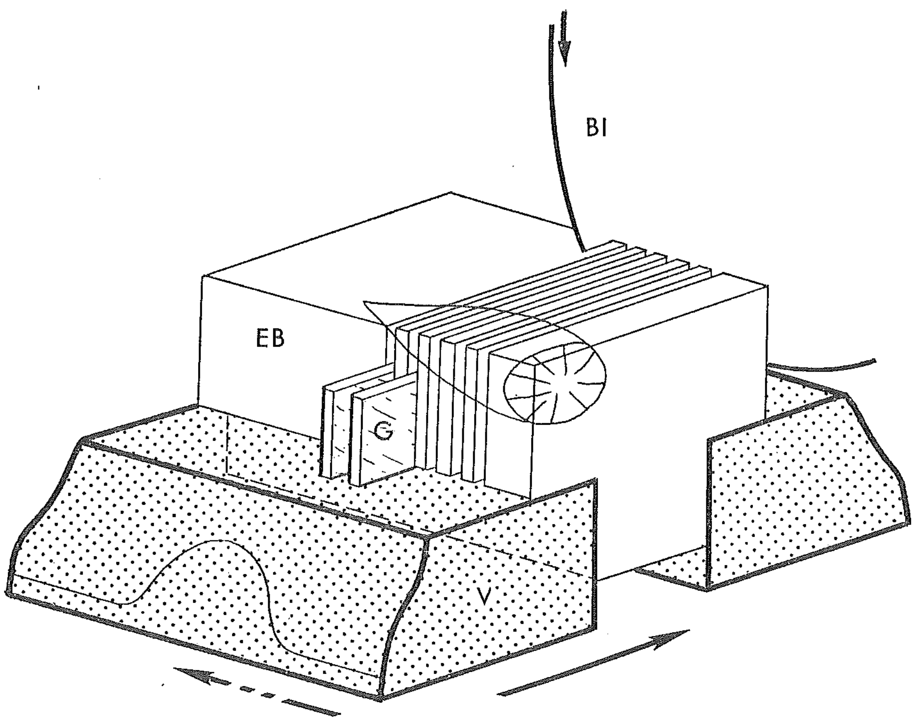

Fig. 2
An epoxy block (EB), in which a fossil specimen is embedded, is worked upon T shape to fit the vice (V) firmly. After each sawing, pieces of cover glass (G) or any flat and thin material of which thickness is close to the saw gap, are inserted into the sawgaps. This practice encourages straight advacing of the extra-thin saw blade (Bl).

the left and right.

The over-all preciseness of the instrument is 2/100 mm. The finishing of the shafts and their bearings are 5/1,000 mm. The instrument is equiped with limit switch system for specimen forwarding, automatic reverse switch, and other automatic and safety operation systems.

Cooling liquid for the blade is 2% ethylenglycole water solution. Approximately 3 litters of pressured coolant is showered throughout the both sides of the blade from closely spaced shawer-holes on the supply tubes which are placed beside the blade. The coolant is circulated through a slime segragation tank.

A piece of rock or a larger fossil specimen is worked by fixing it directly on the vice. A free and relatively small specimen is required to be embedded in epoxy resin.

A coral specimen is embedded in any ordinary epoxy embedding resin such as EPON 812, or for the optimum result, UNOX Epoxide 206 resin (HONJO and FISCHER, 1963) is reccommended. The cured block is then shaped as is convenient to fix on vice such as like being illustrated in Fig. 2.

Thin flake of epoxy plastic is pushed outward by the rotating blade. This results the diviation from parallelism of intervals. Pieces of aluminum or stainless stell foil with the thickness of sawing gap are inserted immediately after a disecting cycle is finished. At least 150 microns thick sample should be left between two saw gaps, in case of carbonate sample is worked. Approximately 500 microns of the sectioning intervals are thus obtained at an optimum condition. The both ends of block should be reserved long enough for emforthment (Fig. 2).

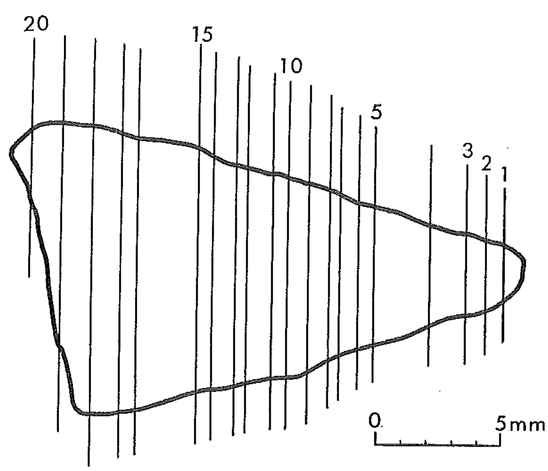

Fig. 3
Illustrating the spacing between the sections appeared in Plate 1. The distance between the sections no. 7 and 8 is approximately 0.3 mm.

When sectioning is all finished, the block is saw off through an end of embedded sample. The thin flakes are carefully taken off through the neck by cutting with a sharp tweezers. A piece of thin foil, inserted in the gap between a flake and the next, is helpful to take the flake undamaged from the block.

The flakes are ready to mount on slideglass. Epoxy resin is used for adhesive. Then grind down to the required thickness with fine abressive powder. Ethylenglycole solution (5%) is reccommended for wettening and lubrication of abressive powder when the epoxy plastic covers the flake more than the carbonate fossil.

Interval	Method
less than 10 microns	Serial micropeel
more than 200 microns	Inner-rim wheel-saw
more than 500 microns	Improved outer-rim wheel-saw
more than 3, 4 millimeters	Regular rock-trimming wheel-saw

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PLATE 1 AND EXPLANATION

Explanation of Plate 1

A part of serial section through a specimen of *Lophophyllidium* sp
Refer Fig. 3 for numbers of the sections. × 4
The specimen has been kindly offered to the outhors by Dr. Kato
Locality and horizon:

C-member of the Sisophon limestone.
South flank of Phn. Tap, Sisophon,
Battambang region, Cambodgia.
Coll. by K. Ishii & M. Kato.

Plate 1