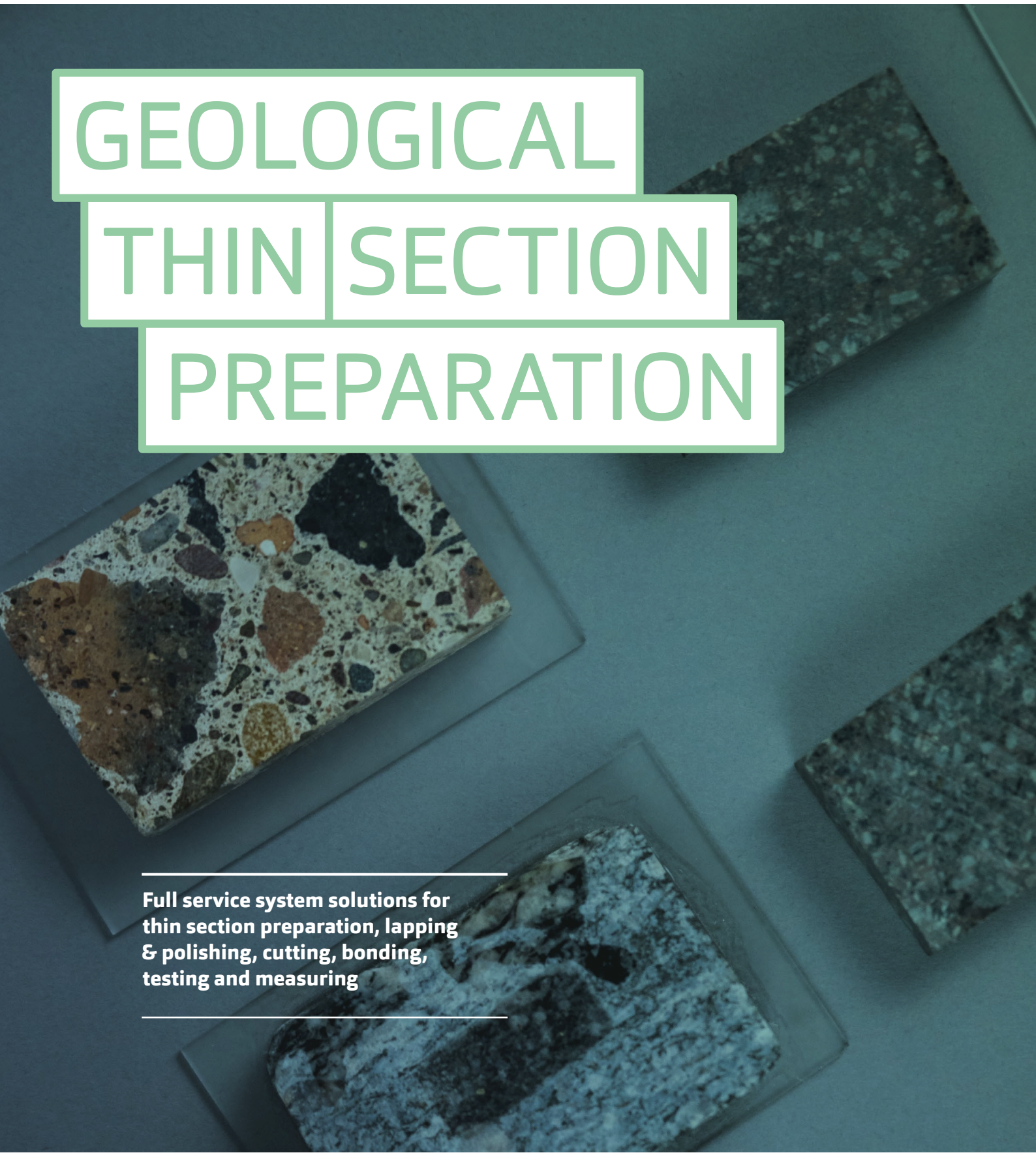
GEOLOGICAL THIN SECTION PREPARATION



Full service system solutions for thin section preparation, lapping & polishing, cutting, bonding, testing and measuring

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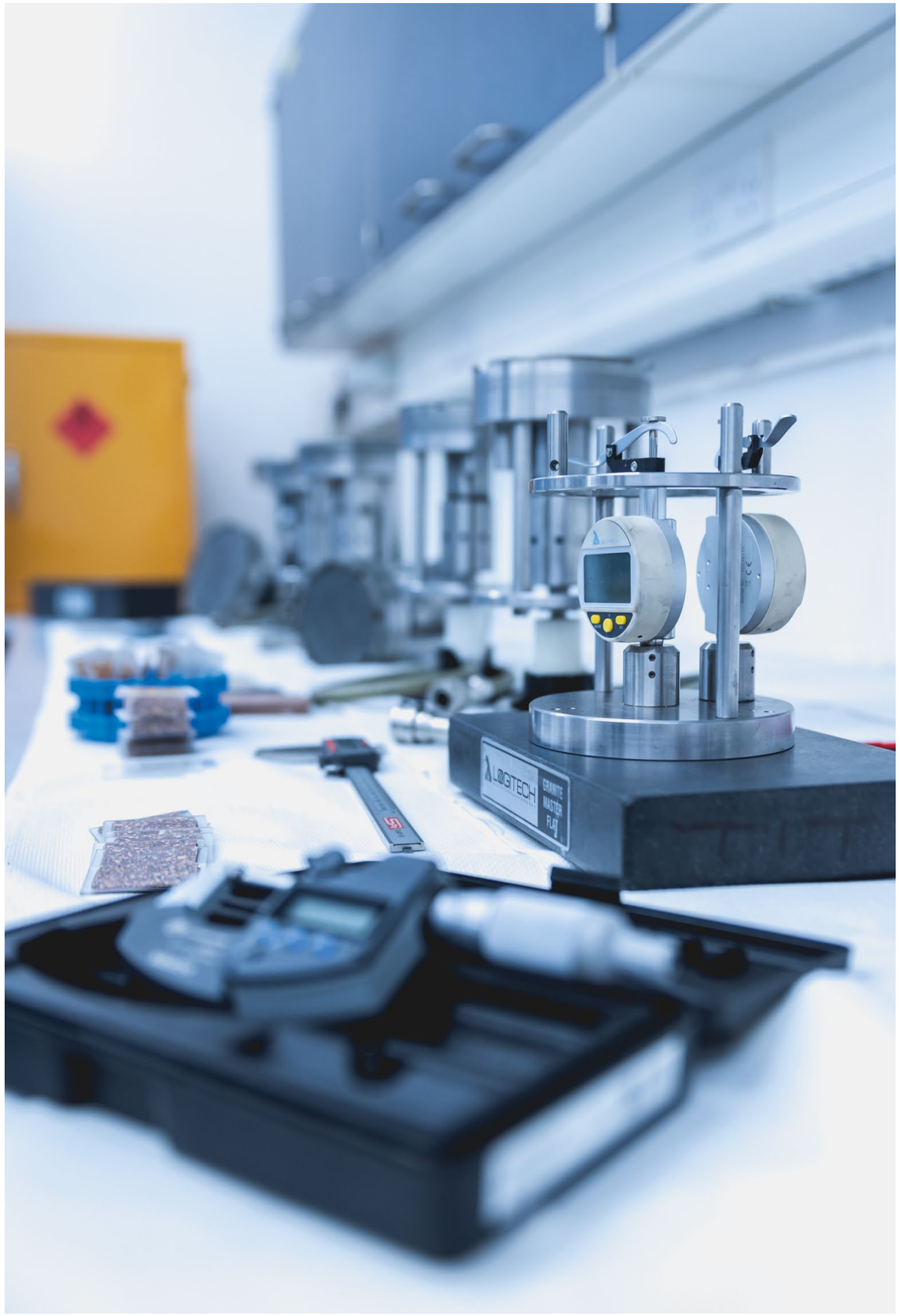
LOGITECH
Materials Technologists & Engineers



PROCESSING SHAPING FINISHING

OBSESSIVE SINCE 1965 PRECISION

"Logitech equipment provides us with very consistent results across a wide range of minerals of varying hardness, this is essential for us to provide a high standard of work. We see very even surfaces with very few scratches and only a small relief depending on the sample material. The polished surfaces we produce are very well suited for automated mineralogy investigations — the core of the Erzlabor product portfolio. Using Logitech equipment allows us to deliver to our customers results that are both precise as well as reproducible."

—

Andreas Bartzsch
Founder, Erzlabor
Head of Preparation Laboratory
at the Helmholtz-Institute

Logitech is a world leader in materials processing, shaping and surface finishing technologies. The business developed from a spin-off project at the University of Glasgow, one of the world's oldest and most respected academic institutions. Since the 1970's, Logitech has received global recognition as a leading exponent in geological thin-section preparation, and is continuing to develop these leading processes to maintain this position.

We specialise in the design and manufacture of lapping and polishing equipment. Also in cutting, bonding, testing and measurement equipment, which provides a full geological thin-section preparation system solution. We bring a wealth of knowledge and problem solving skills in the production of high quality thin or ultra-thin sections of:

- Rock
- Coal
- Concrete
- Soils
- Fluid Inclusions

By working with you, we can assist in the integration of the relevant processes and systems to meet your material processing requirements, such as: weekly output, surface finishing and geometric tolerances.

Generally, standard thin section preparation can be broken down into the following basic steps:

- Slabbing and trimming of field specifications
- Impregnating soft, porous or friable materials
- First face lapping of cut material
- Preparation of slides to uniform thickness
- Bonding specimens to prepared slides
- Thinning bonded specimens
- Lapping specimen to chosen thickness
- Polishing specimens *(optional)*

PROCESS ROUTE

Step 1· Slabbing & trimming

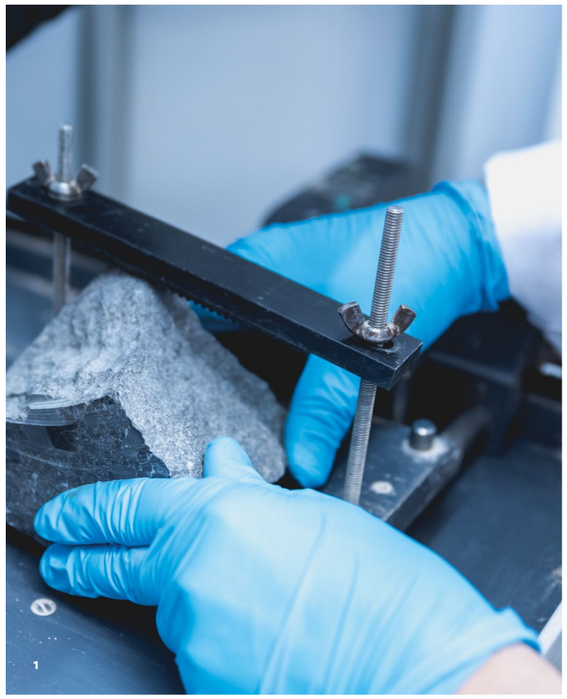
The first stage in the thin-section preparation is cutting the sample to a suitable size for processing. This small section must first be removed from a larger rock sample.

The GTS1 Thin Section Cut-off and Trim Saw is ideal for geological applications and allowing users to cut hard or soft rocks, concretes or cement, with equally high efficiency. The GTS1 can be used for both cutting the bulk rock size and for thinning the slide-mounted rock chips prior to final lapping. Bulk materials can be processed more efficiently by mounting these on the sample table before cutting.

Step 2· Impregnation

If a material is too soft, porous or friable in its raw state, the material must be impregnated with a synthetic resin before it is processed. The Logitech IU30 Impregnation Unit is designed to encapsulate and impregnate specimens with synthetic Logitech resins, allowing for safe processing without sample damage.

The IU30 is ideal for impregnating large samples and multiple samples. It is the ideal solution for laboratories with a high volume requirement for impregnated materials.



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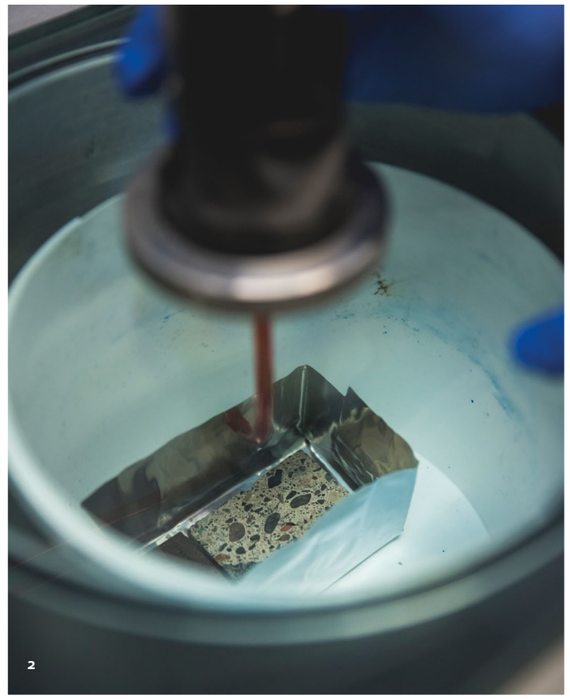

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Step 3· First face lapping

The first stage of lapping is carried out on the PM6 precision lapping & polishing system / LP70 precision lapping & polishing system. The samples are placed inside a steel retaining ring with a pressure block and loading weight placed on top. This is then mounted on to a cast iron lapping plate for processing. With a rotational plate speed of up to 100 rpm (PM6 / LP70) with the aid of an abrasive slurry.

One of the most important developments in thin section processing, in recent years, has been the introduction by Logitech of automatic plate-flatness control with the PM6 and LP70 auto precision lapping machines. This almost completely eliminates the most difficult task of the lapping process — controlling the plate shape. Changes in plate shape during processing can cause rounding to the sample.

Lapping plate-flatness control improves the quality and repeatability of the thin sections produced. It is of tremendous advantage to the operator — freeing-up time which would otherwise have been spent supervising the machine supervision for other tasks, such as analysis and improving the overall productivity of the thin section production system.

PM6

Process conditions are set up from the GUI on the PM6. The user can control conditions such as material removal, plate and jig speeds and abrasive slurry delivery.

The PM6 allows operators to produce around 100 standard thin sections per week using a single station. With optional auto-lap, and utilizing the PLJ2 precision lapping jigs, they can produce sections of repeatable uniform thickness. Intelligent features of the PM6, including recipe mode and automatic plate flatness for easy process repeatability, allows operators to produce high quality thin sections with every process.

LP70

With four workstations as standard, the LP70 precision lapping & polishing system has the output capacity to produce approximately 300–500 standard thin sections per week. The LP70 can operate with four PLJ2 (or three with an automatic plate flatness monitor) or two large format PLJ7 precision jigs (or one PLJ7 and an automatic plate flatness monitor).

The highly automated features of the LP70 allows for easy process repeatability in uniformity and thickness across each individual section. This method allows a standard thin section to be produced to a final desired thickness as thin as 10 µm.

1: Bulk rock being fed by hand through the GTS1 saw

2: Sample impregnated with synthetic resin using the Logitech IU30 Impregnation Unit

3: The cut samples are placed within a steel retaining ring with a pressure block and loading weight for first face lapping

3

Step 4· Preparation of slides

Before any specimen can be mounted to the slides for further processing, the microscope slides must first be prepared to the required uniform thickness for sample consistency.

The slides are vacuum-mounted to a Logitech precision jig before being lapped on a lapping and polishing machine to the required thickness.

4: Bond multiple samples with zero dimensional error with the Logitech Bonding Jigs

5: Mounted samples are held in place on the GTS1 Saw via a vacuum chuck face slide holder, samples are then trimmed to as thin as 300 µm to reduce lapping time

Step 5· Bonding specimen to slides

The production of thin and ultra-thin sections of materials requires that the sample materials are fixed to the prepared microscope slides. 'Zero bonding' and controlled-thickness bonding are both important techniques developed by Logitech to enable thickness to be controlled easily and with great precision.

The sample / slide combination is assembled using epoxy resin and is placed within a Logitech Bonding Jig on a hotplate, where pressure is applied and the sample remains until the resin cures. Bonds made in this way are extremely clear, free of bubbles, and introduce zero dimensional error into the machine section-thickness control procedures.

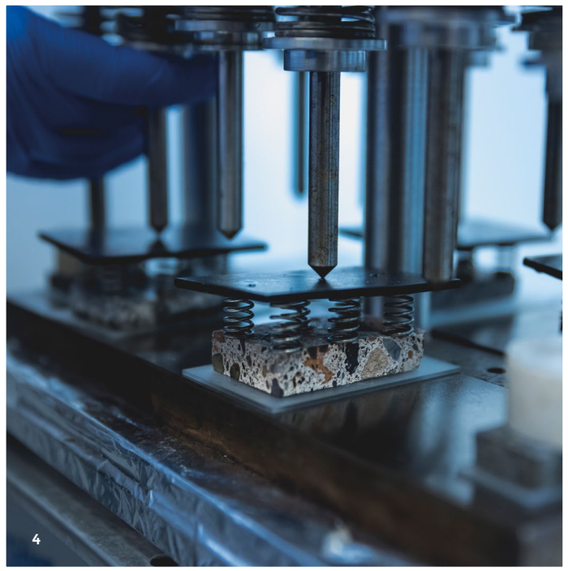
Logitech bonding jigs are available for large or small scale operations and have the capacity to hold single large specimens or multiple smaller specimens. The BJ12 has two sets of six loading pistons on either side of the central line and can accommodate up to 12 samples.

Step 6· Thinning bonded specimen

Once the sample has been safely bonded to the slide, the excess sample material must be trimmed to prepare for the final lapping stage. The thinned rock sample should be as thin as possible to reduce lapping time, and the cut surface kept to the highest possible quality to reduce sub-surface damage. The GTS1 allows users to trim samples to as thin as 300 µm, affording a potential to increase productivity.

The functional system allows for automatic operations for the thinning of mounted samples. The samples are held in place by the vacuum chuck face slide holder which is mounted on to the sample table. The slide holder passes parallel to the saw blade at a user-adjustable distance.

The variable-speed, linear-drive system and feed-rate monitor on the GTS1 allows the operator to control the rate at which samples move through the cutting process, avoiding many of the problems associated with gravity-fed systems such as material shattering. The operator can set the optimum rate for the material being cut via the saw's user-friendly control panel, ensuring sub-surface damage is minimised.



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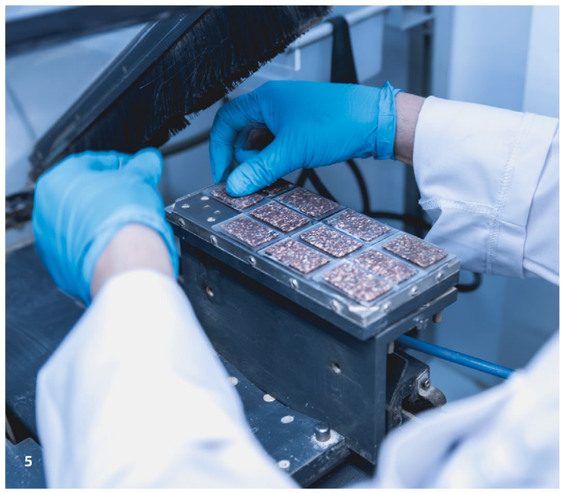

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Step 7· Lapping specimen

The cut sample is now ready for the final lapping stage on the PM6 / LP70. The slides will be mounted upon a Logitech precision jig. The slides are fastened by vacuum to the chuck face where they will be held securely throughout the process. The vacuum chuck face is also adjustable for step height for high levels of accuracy.

The loaded precision jig is then placed in the lapping machine where the cast-iron plate will remove specimen material, resulting in low-damage and smooth surface finishes.

6: Logitech PLJ precision jig mounted upon the PM6 with the automatic plate flatness monitor

7: The WG6 polishing head allows the polish of multiple samples simultaneously with loads of up to 1·4 kg per drive rod

Step 8· Polishing specimens

The final stage in the production of geological thin sections is to polish the specimens, although this is not always required for thin sections, but a critical stage in ultra-thin section preparation.

Ultra-thin sections are required to be polished on both faces. Trimmed chips are first free lapped according to the standard process route up to step 3, they then must be 'free' polished under load in a conditioning ring on a Logitech lapping and polishing machine such as the LP70 or PM6. When polishing is complete the chips can be mounted, polished side down, on a prepared glass slide, thinned and lapped down to 25–30 µm and thereafter polished using the WG polishing head on a geochem pad to the required final thickness. Down to less than 10 µm in some cases.

The Logitech WG6 polishing system, comprising of a PM6 or LP70 lapping & polishing machine and a WG6 polishing head (two on the LP70) is capable of producing the desired finished sample to a very high standard. This can be high reflectivity, low relief and ultra-flat surfaces.

This highly versatile system can polish a batch of up to six samples at one time on a PM6 and up to 12 samples at one time on an LP70. Samples can also be polished individually, using a variety of sample holders. The WG6 offers a wide range of facilities including variable carousel speed and rotational direction and the powerful, low-voltage motor provides sufficient torque to rotate the fully loaded carousel at a speed of up to 50 rpm.

Incremental loads of up to 1·4 kg may be placed on each individual drive rod to assist with the polishing process.

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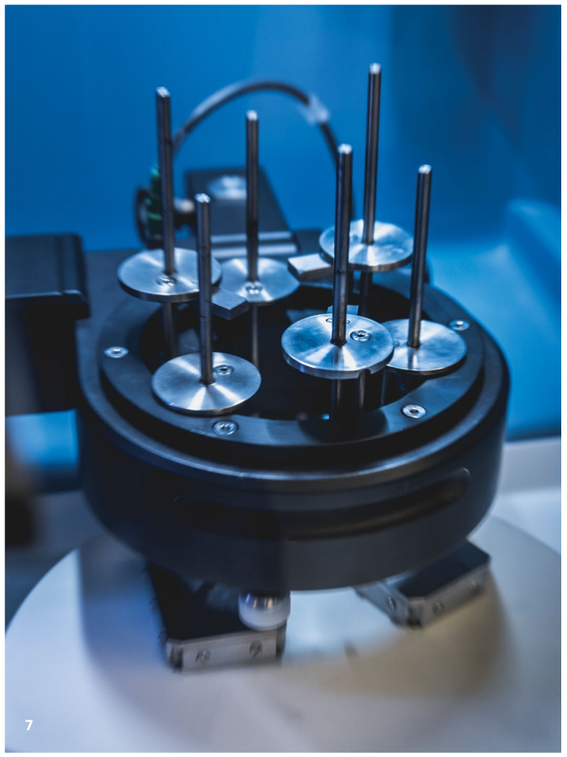

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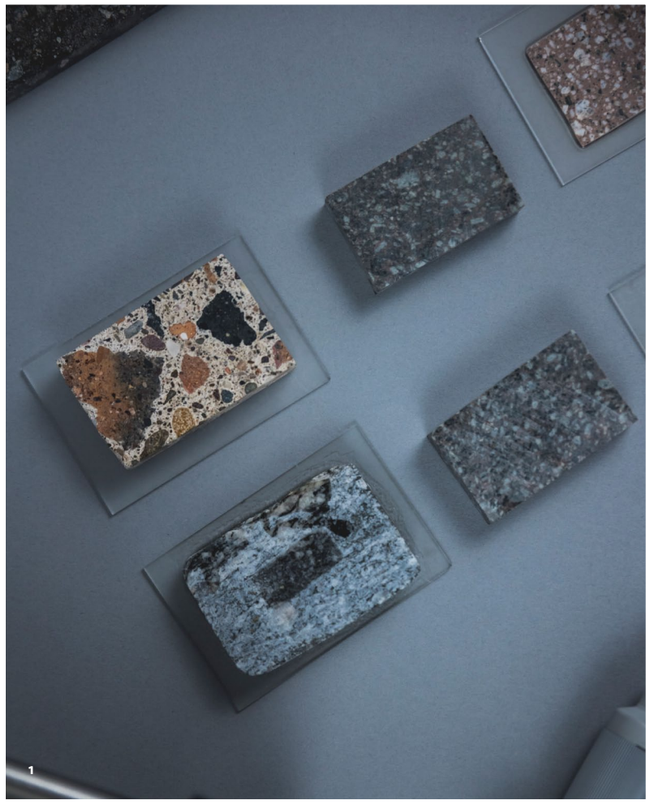
In addition to standard thin and ultra-thin section production, Logitech systems are versatile enough to accommodate material requiring special processing techniques such as concretes, fluid inclusions, coals and soils. Non-geological materials such as bone implants and tooth are also catered for.

1: Logitech offer versatile systems to accommodate different material types

2: The thickness of microscope slides and bonded thin sections can be measured using a micrometer



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Soil

Before any processing can begin, water must first be removed from the soil. Normally the sample is left in a well ventilated area for several days until a constant weight is achieved and then dried on a hotplate at 40°C for 48 hours.

The soil is ready for impregnating on the IU30 Impregnation Unit (**step 2** of the standard process route). Once the resin has cured, the sample is trimmed on the GTS1. A non-aqueous solution, for example ethylene glycol, can be used as a coolant to avoid damaging the soil. Water should *not* be used. The samples are then 'free' to undertake the first face lapping as describe in **step 3**.

Aluminium oxide abrasive must be used with impregnated material and it must be in a carrier fluid with a low water content, *eg* ethandiol, as the soil particles retain large volumes of resin two or three stage lapping may be necessary *ie* start with 15 µm, continue with 9 µm and finish with 3 µm abrasives.

The lapped face is then cleaned and bonded immediately to avoid any distortion effects. Bonding is carried out according to **step 5** of the standard process route, but for larger specimens it is necessary to use the high pressure station of the BJ6 or BJ12 Bonding Units.

Once bonded, the sample is thinned as dictated in **step 6** using ethylene glycol and a coolant. Lapping then follows as per **step 7** and again three stage lapping may be necessary. Abrasive carrier fluid should be non-aqueous such as ethandiol. Final polishing is achieved on a geochem polishing pad with the sample held in a vacuum chuck holder.

Concrete

Thin sections of concrete are prepared for a number of different tests; porosity determination, inclusion analysis and mineral composition for example. To make analysis easier, in particular for porosity testing, the pores in the concrete are defined more clearly by impregnating them with dyed resin. Normally the dye is mixed with the resin before being used to impregnate the specimen in the IU30 Impregnation Unit (**step 2**). As a result of impregnation, the dyed resin fills all the pores and makes them easily distinguishable from the surrounding material. Fluorescent dyes can be used if required. Whether dyed or not, concrete specimens must be either fully or surface impregnated to permit further processing.

Thereafter, the standard process route is followed with some minor alterations to produce the finished thin section. Trimming the specimen is carried out as per **step 1**, but to prevent water damage, a non-aqueous liquid such as ethylene glycol is used as a coolant. This also applies at the thinning stage (**step 6**). To avoid any damage and contamination during lapping (**steps 3** and **7**) aluminium oxide abrasive should be used instead of silicon carbide and in view of the susceptibility of concrete to water, the abrasive is a non-aqueous carrier fluid such as ethandiol.

Fluid inclusion studies

Specimens used for fluid inclusion analysis require to be polished on both sides as the inclusions are so small that they would be obscured by the larger surface features of the lapped surface. First the chips are trimmed and free lapped (as **steps 1** and **3** on the standard route).

After lapping, the chips are also free polished (*ie* under load on a polishing pad or soft metal plate). They can be mounted, polished side down or on a prepared glass slide, either with resin if the finished section is not to be demounted (as per **step 5**) or with wax or other 'temporary' adhesive if the specimen is to be demounted later.

Final thinning, lapping and polishing can then be carried out exactly as for a standard thin section (**steps 6–8**) if the finished thickness requirement is in the normal 80 to 250 µm range or using the techniques described for ultra-thin section preparation.

Coal

Coals are particularly difficult materials to process. They are generally friable, prone to distortion under small stresses, heat sensitive and opaque, thus requiring a section of less than 10 µm thick to define the structure clearly under the microscope.

A special steel base is inserted in a 25 mm diameter plastic mould, into which the coal specimen is then placed for impregnation (**step 2**), once the resin has cured, the impregnated specimen is removed from the mould and the top is trimmed off using the CS30 saw. The trimmed face is then lapped and polished, with the option of processing using either a conditioning ring (**step 3**) or the WG6 Polishing Head with an appropriate system.

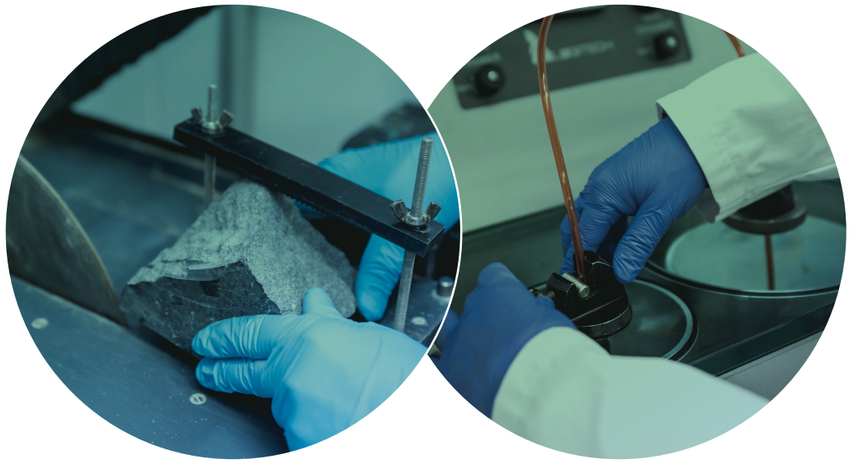
A suitable number of resin 'pips' are placed on to an untapped slide. These serve as support pillars to the coal section. The pips are lapped to a thickness of 50–80 µm on the PLJ2 Precision Lapping Jig, co-planar and parallel to the back of the glass slide and with the slide still mounted on the jig, the polished face of the specimen is bonded to the pips. Once the resin has cured, the excess material, including metal mould base, is cut off and the specimen is lapped and polished according to the standard process route (**steps 6–8**) but to a final thickness of 8–12 µm.

MATERIAL SPECIFIC PROCESS ROUTES

EQUIPMENT | GLOSSARY

Process capabilities

Material:	granite rock
Abrasive:	SiC lapping abrasive
Plate speed:	100 rpm
MRR:	25 µm per min



GTS1 thin section cut-off & trim saw

The GTS1 is a compact, bench-top unit for the preparation of geological thin sections. The saw is ideal for cutting bulk rocks and thinning. Trim rock samples to as thin as 300 µm with cuts of the highest quality ensuring sub-surface damage is kept to a minimum. Variable speed linear-drive system and feed-rate monitor allow the operator to control the rate at which the samples move through the blade, avoiding many problems associated with gravity-fed systems, such as slides shattering. The GTS1 accepts multiple slides up to 12 of 28 x 48 mm.

IU30 Impregnation unit

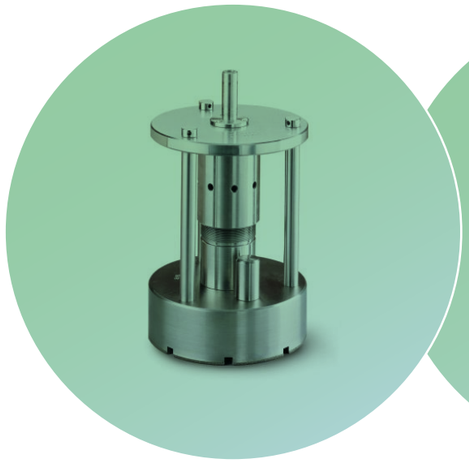
The IU30 is a self-contained unit for high quality encapsulation and impregnation of specimens with synthetic resins. This simple to use system is a key Logitech product with geological researchers, as it is ideal for impregnation of soft, porous or friable materials such as; soils, concretes, cements and clay. The IU30 allows both sample and resin to be evacuated separately and enables resin to be delivered to the sample while it remains under vacuum. It is of particular benefit for high volume laboratories and for impregnation of large sample formats for sections up to 150 x 100 mm (6" x 4").

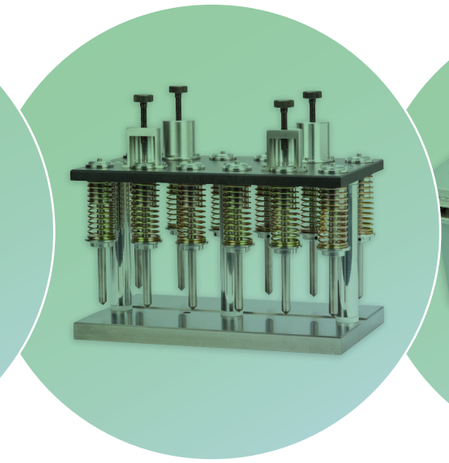
PM6 precision lapping & polishing system

The PM6 is a highly automated precision lapping & polishing machine producing results typically found on production scale equipment. This single-station, benchtop machine has plate speeds of up to 100 rpm facilitating faster lapping rates, optional automatic plate flatness control and Bluetooth-enabled features such as automatic plate flatness monitor software.

LP70 multi-station precision lapping & polishing system

The LP70 is a benchtop multi-station lapping & polishing system with four workstations as standard. Designed to run concurrent automated processes, allowing operators to achieve repeatable results to stringent sample specifications. The LP70 also has Bluetooth-enabled features such as automatic plate-flatness montior software.





PLJ precision jigs

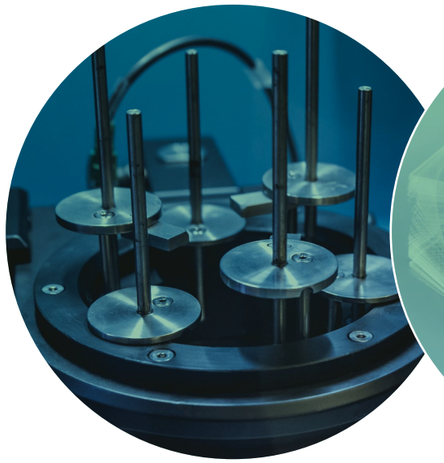
Logitech PLJ precision lapping jigs are used to hold multiple slide-mounted specimens via vacuum while they are being processed on a precision lapping machine. These allow the specimens to be automatically lapped to a high degree of parallelism and flatness. The robust construction of these jigs ensure they are suitable for both research and production environments and are ideal for the use in geological applications. Maximum sample capacity of 152 x 102 mm (6" x 4"), or multiple smaller samples.

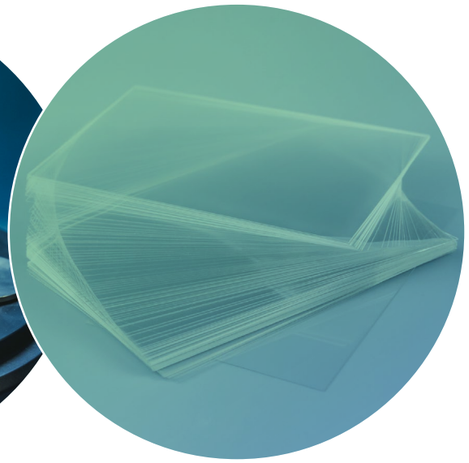
Bonding jigs

'Zero bonding' and controlled-thickness bonding are two important techniques developed by Logitech to enable thickness to be controlled easily and with great precision utilising the bonding jig range. Our bonding jigs are available with 12, 9, 6 or 2 pistons for large or multi-section 'zero bonding'. Bonding jigs are suitable for large or small scale operations.

Hotplate

The Logitech digital hotplate features a precision PID controller providing degree-by-degree temperature settings and control, with refined hotplate sensitivity. Temperature and time settings are retained in memory, even after power off.





WG6 polishing system

The Logitech WG6 polishing system, comprising of a PM6 / LP70 system and a WG6 polishing head, is capable of producing the desired finished sample to a very high standard. This can be high reflectivity, low relief, ultra-flat surfaces or minimal edge roll off. This is a highly versatile system offering a wide range of facilities including variable carousel speed and rotational direction. With a capacity to polish a batch of up to 6 samples at one time, or individually, using a variety of sample holders per polishing head. The WG6 is an ideal system for thin section polishing.

Logitech consumables

Logitech offers an extensive range of certified consumable products, carefully developed to work in unison with our geological thin section preparation systems. From microscope slides to bonding resins our own research and analysis provides us with the expertise to achieve the best results from Logitech equipment. Utilising Logitech's consumable range with your Logitech system will enable you to achieve optimal performance and maximise the lifespan of your Logitech equipment.

TECHNOLOGY TRANSFER

"The combination of precision tolerances and high sample throughput on Logitech's lapping and polishing equipment enable our laboratory to produce research-grade thin sections at a speed necessary to keep up with campus and external demand. The auto-plate flatness technology saves hours of downtime each week while allowing us to hold a roughly one-micron flatness tolerance, worry free, during critical steps of thin section production."

—

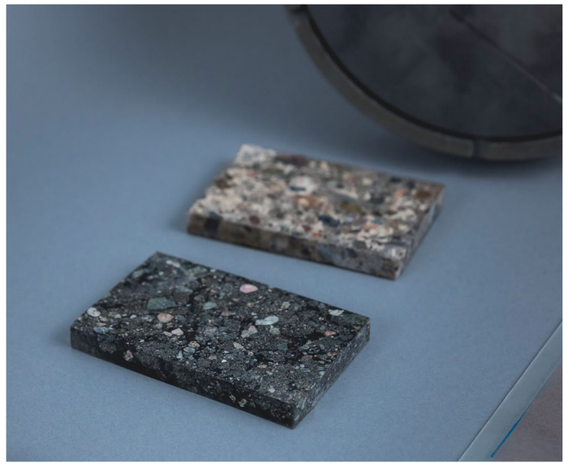
Jae Erickson
Laboratory Co-ordinator
Colorado School of Mines

Logitech's Technology Transfer programme is an integral part of our materials processing systems. Our training courses offer over 50 years of processing expertise and have proven to be the best method of providing information and guidance on the use and maintenance of our systems.

Our training courses are held at our purpose built laboratories at Logitech in Scotland. With over 50 years of combined experience, training will be given by our process development engineers, demonstrating the most up-to-date and advanced process techniques available. Trainees benefit from our continuous research and development, which means that process methods are improved and updated constantly.

Emphasis is placed on trainees producing their own work, allowing them to create the highest standard of specimen possible, adhering to strict application specifications, using process methods introduced and coached by our engineers. Each course is limited to just two or three individuals, usually with similar training needs, allowing for close, often individual, tuition.

As the course is tailored to your exact requirements, all of your specific needs and problems receive full attention. Our dedicated process team are always on hand, on-site, or reachable by email, to offer further advice and problem solving knowledge.



OBSESSIVE SINCE 1965 PRECISION

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