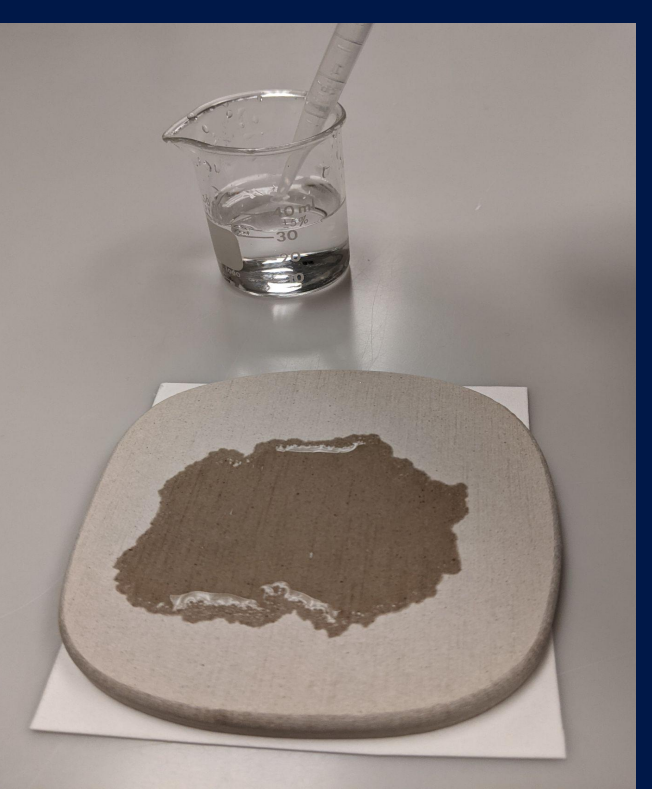




Diatomaceous Earth Stones as a New Tool in Paper Conservation

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Introduction

Sustainability has become a recognized necessity in the field of paper conservation. Cotton blotter paper and woolen felts, commonly used in various paper conservation treatment procedures, are expensive. Moreover, blotter papers have limited use after an aqueous treatment due to distortions. The pursuit of a more sustainable, cost-effective, absorbent, safe and distortion-free material led to the introduction of some non-woven, man-made fiber blend fabrics such as Evolon® and Tech-Wipe (1) which became useful conservation tools. This poster evaluates commercially produced diatomaceous earth bath mats/stones (aka DE stones) and their viability as a helpful new tool for improving sustainability in paper conservation.*

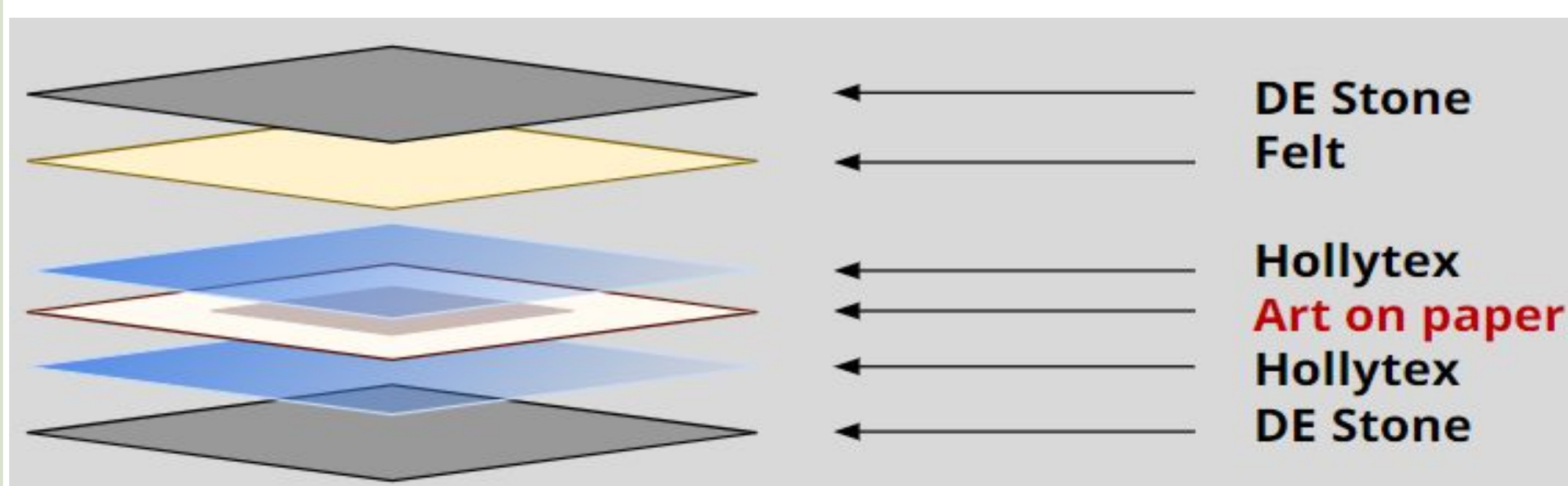


This poster assesses whether DE stones may be safely used as reusable, sustainable, absorbent, cost-effective, and distortion-free alternative to blotter papers in drying procedures.

*DE stone manufacturers, Sutera and Dorai, claim that the products are all-natural, safe and inherently bacteria and mold resistant.

Treatment Applications

- DE stones provide an absorbent rigid surface helpful when removing paper from immersive baths (use a brush to maintain even contact).
- DE stones can be used in drying procedures of humidified or damp paper objects. They are especially effective when combined with other absorbent materials such as felts (see diagram below).
- DE stone's surface offers a rapid moisture reduction; it is useful when pasting hinges or mending strips. This lowers the risk of creating a tideline when dealing with unwashed artifacts. The paste residue can be washed out with a soft brush and water. When fully saturated with water, the DE stones require at least 24-48 hours of drying time.



Left: a print drying as in the diagram; Center/Right: used as an absorbent surface

Pros and Cons

- **Combination of absorbency, rigidity and some weight**
- **Smooth and absorbent surface useful in some paper treatment procedures such as drying, hinging, tear repair**
- **Reusability/sustainability helps lower the cost of drying materials**
- **No deformation or warping as the moisture is absorbed**
- **Negligible concern about mold growth**
- **Relatively small sizes: 23 ½" x 15 ½" x ¼" (single largest stone)**
- **Rounded corners create a corner gap when the stones are combined**
- **As a commercial product it can be discontinued**
- **As a commercial product it can be altered without notice**

Acknowledgements

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Diatomaceous Earth Stone vs Blotter

material	diatomaceous earth stone	cotton fibers
optical brightener	no	depends on manufacturer
pH	8.5-9.0*	7.0*
water absorbed	60% of its weight	320% of its weight
thickness	9 mm (less than 1 cm)	0.9 cm
planar stability	does not distort when wet	distorts when wet/dry
solvent reactivity	unreactive**	unreactive**
sustainability	reusable and washable	not as reusable
price	\$20-90 per stone***	\$6.96-8.50 per sheet
maximum size	23.5" x 15.5" or 22.3" x 31.6"	24" x 38" or 32" x 40"
weight	4 lb/2 kg	

* pH of wet DE stone was taken with a pH strip and TAPPI pH cold extraction method; cotton blotter pH data obtained from the producer. ** ethanol, acetone, toluene, and xylene tested ***DE stones are sold at different prices; Dorai and Sutera products were analyzed and priced

Diatomaceous Earth

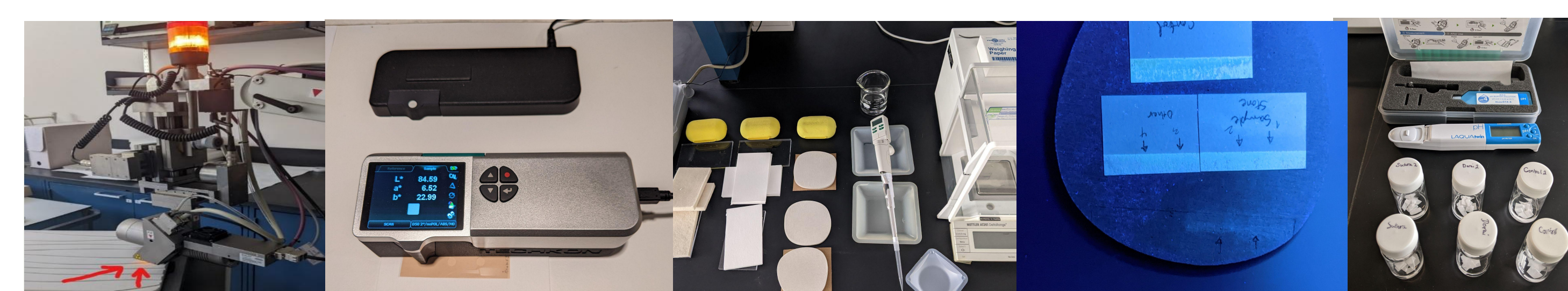
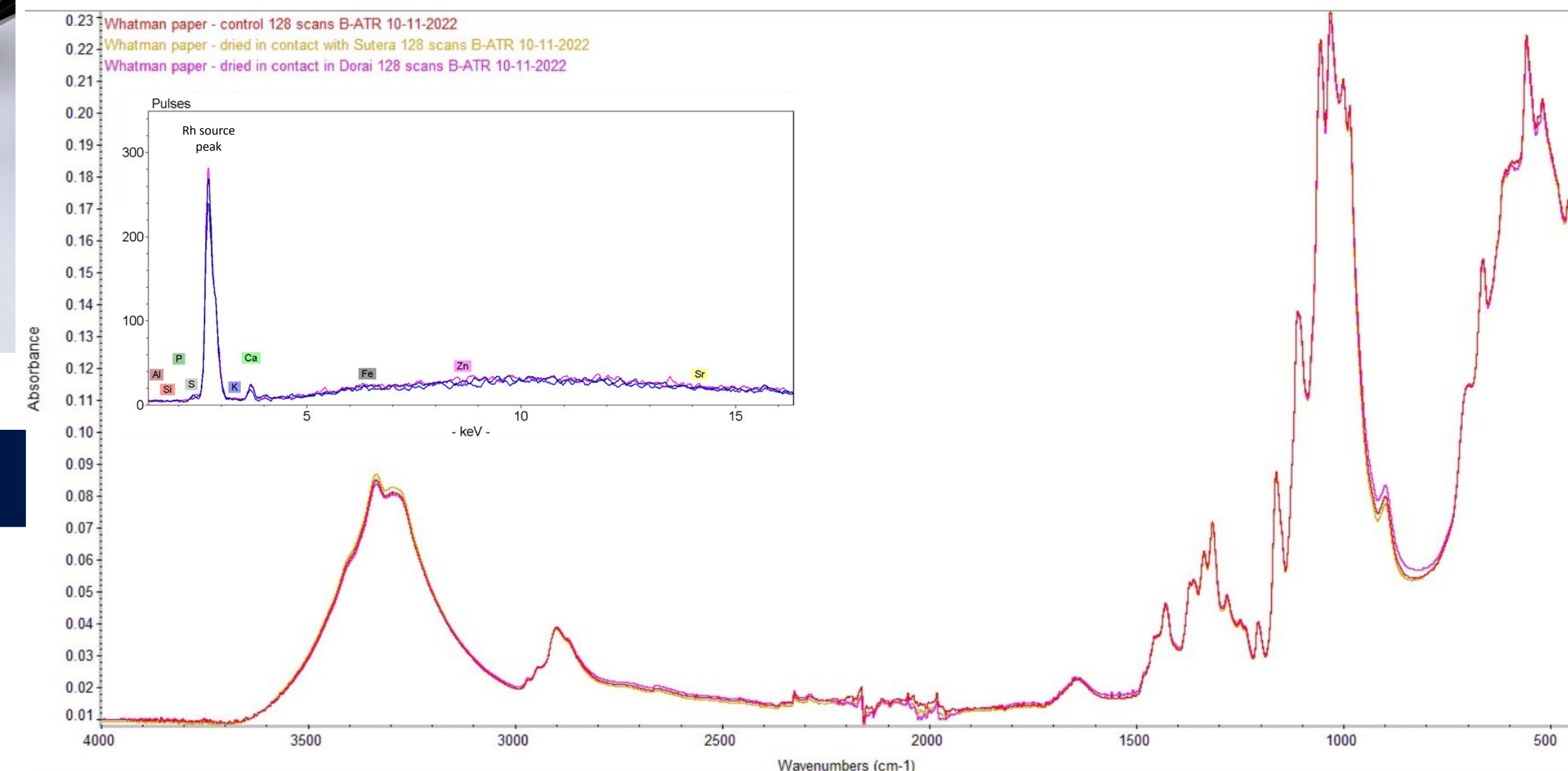


The DE stones are composed of diatomaceous earth, a naturally occurring, clay-like material. Diatomaceous earth is biogenic sedimentary rock rich in fossilized diatoms. Diatoms are single celled, aquatic organisms varying in size from 5 to 100 micrometers. These aquatic organisms live in both fresh or saline water habitats and come in many shapes. They were first observed in the 18th century by A. Leeuwenhoek.

XRF and FTIR and Results

Instrumental analyses of the stones as well as Whatman filter paper samples dried in direct contact with the DE stones gave encouraging results for the viability of this new tool. The XRF and FTIR analyses of the two DE stones found no substances of concern in the chemical composition. The XRF showed strong peaks for silicon, calcium, and iron. The FTIR showed carbonate and silicates.

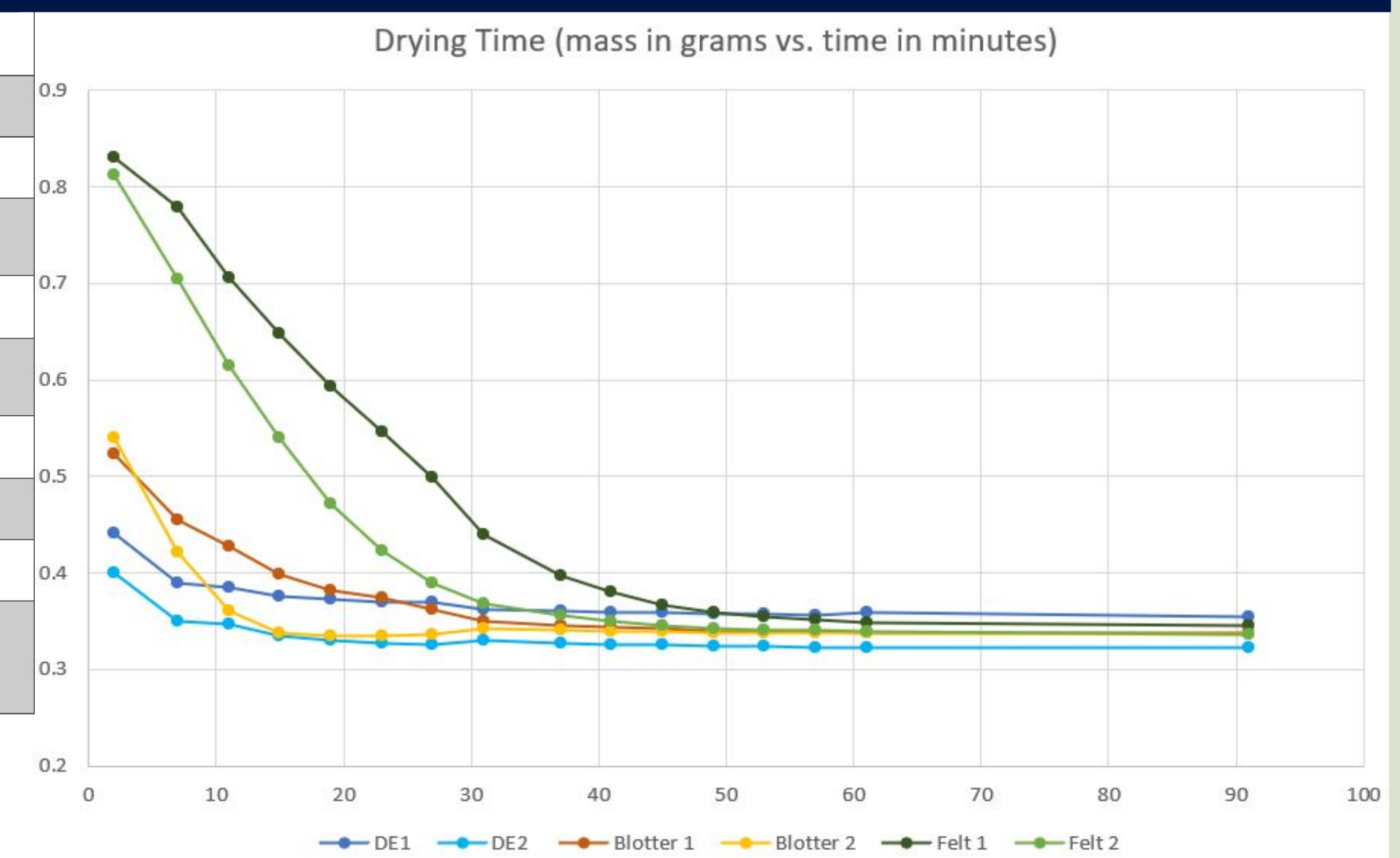
No undesirable transfer was detected from the stones to a wet piece of Whatman filter paper dried directly in contact with the DE stones. The FTIR and XRF analyses of the samples of paper dried between the stones matched that of a control paper (which had no contact with the DE stones). The larger figure below compares the FTIR spectra of paper dried between the DE stones vs. a control paper and the inset compares the XRF spectra of the same samples.



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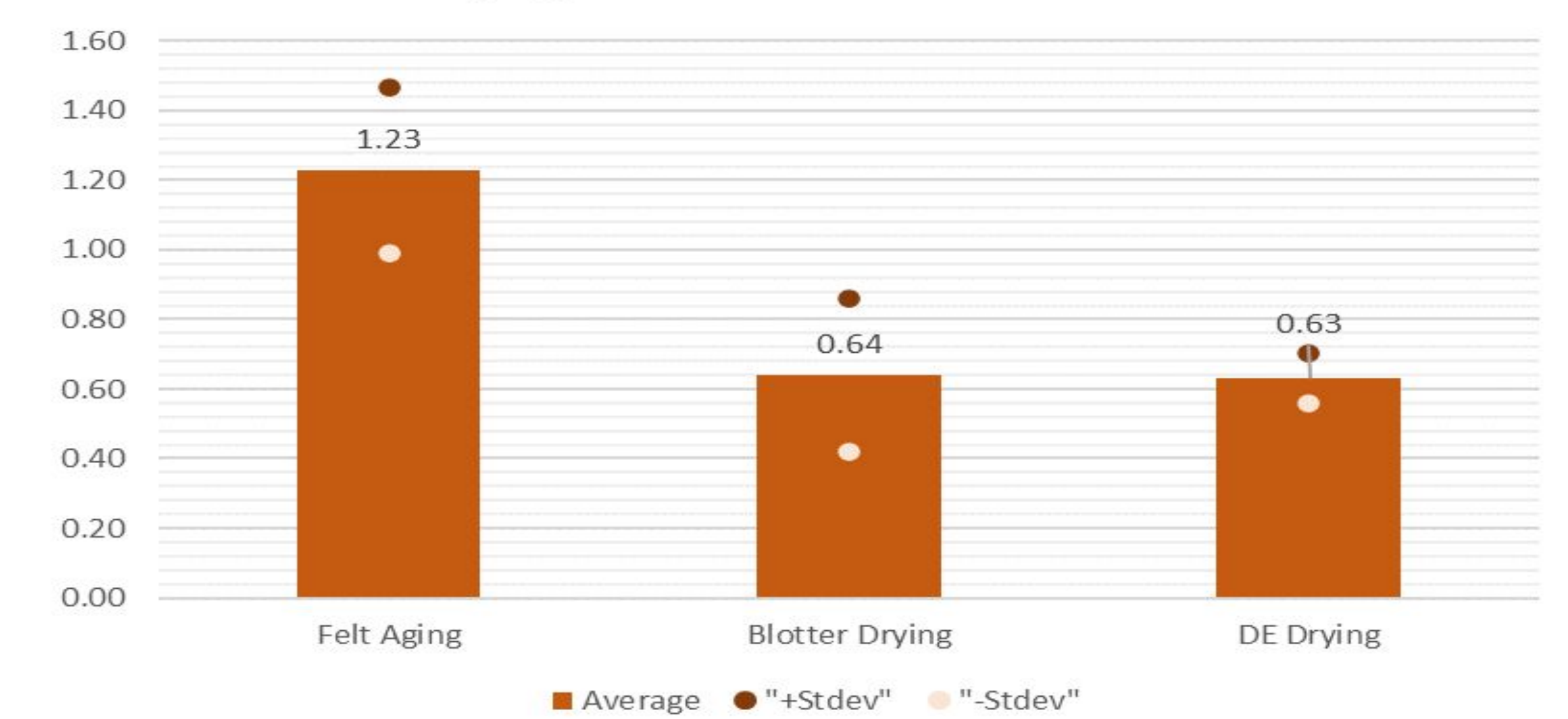
Gravimetry Results



Gravimetric analysis compared wet paper samples dried between DE stones (made by Dorai and Sutera), cotton blotters, and woolen felts. The results shed light on the drying rates and absorption mechanisms of the different materials. When the same amount of water is applied, DE stones initially absorb moisture from the filter paper much more rapidly than cotton blotters or felts; the paper dried between the DE stones had already lost a measurable amount of water in the first 2 minutes compared to the blotter or felt. All reach similar dryness by 50 minutes.

Colorimetry

Delta E of Paper Using Different Drying Techniques After Aging at 70°C and 65% RH for 4 weeks



Color measurements of the gravimetric experiment paper samples were taken before and after accelerated aging. The papers dried in contact with blotter and DE stones show minimal (well below a just noticeable change of 1.5 ΔE) color change after aging. Felt-dried samples showed only a little less than the just noticeable change.

pH Results

pH of Whatman filter paper samples dried against DE stones and the control dried between blotter was measured via cold extraction before and after accelerated aging at 70°C and 65% RH for 4 weeks:

Filter paper dried between:	DE stones	Blotter
pH of filter paper after drying	9.06	9.03
pH of filter paper after aging	8.32	8.12

The results suggest that using DE stones to dry paper **does not negatively affect the aging of paper** as measured by change in pH.

Conclusions

Based upon material characterization from analytical results and aging studies, **DE stones appear safe for use as an alternative to drying with blotter paper.** The results suggest that the DE stones do not affect the color or pH of paper dried in contact with the stones, and the XRF and FTIR analyses did not find any substances of concern. Because only plain paper samples were studied, any use with friable media or colorants would need to be studied further. This research used direct contact with the stones as a "worst case scenario" but the use of a clean Hollytex insulating layer is suggested for best practice. Best practice would also suggest rinsing the stones prior to use to remove any loose residue.