

## Letter Section

## INEXPENSIVE FIELD TECHNIQUE FOR POLYESTER RESIN PEELS OF STRUCTURES IN UNCONSOLIDATED SEDIMENTS

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## ABSTRACT

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McCullen and Allen's (1964) technique for making polyester resin peels of sedimentary structures in wet unconsolidated sediments is made more practical for the field and less expensive by using new lightweight spraying apparatus, disposable cans of propellant, and resins that are readily available from local suppliers. This revised method produced excellent relief peels in a range of sediment types from Miocene strata of Maryland (U.S.A.), including clean coarse and fine sands, silty sands, sandy silts, and interbedded clays and sands, both wet and dry. By bonding a cloth backing to the peel during its construction, the finished peels are remarkably sturdy even before being cured completely, and can be transported without the special wood or metal supporting sheets required by other methods.

## INTRODUCTION

Several techniques have been developed for preserving sedimentary structures in unconsolidated sediments (Heezen and Johnson, 1962; Bouma, 1964; Maarse and Terwindt, 1964; Burger et al., 1969; Minoura and Conley, 1971; Ashley, 1973; Ostler and Martini, 1973; Bull, 1977; Getzen and Levey, 1982), but the polyester resin method of McCullen and Allen (1964) remains one of the best, both because it works on wet as well as dry sediments and also because it does not require any special preparation of the sediments such as box-coring. The impregnation method of making a relief peel depends upon differential penetration of sedimentary layers by a liquid, in this situation a heavier-than-water epoxy capable of displacing porewaters. Bedding plane features are preserved by pouring the resin gently onto the sediment surface, which is first covered with muslin. The resin impregnates the sediment due to gravity, with the rate and depth of penetration con-

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trolled by the difference in specific gravities of the resin and water, their immiscibility, the viscosity of the resin, and the permeability and water content of the sample.

McMullen and Allen (1964) also described a procedure for preserving structures in vertical or sloping outcrop surfaces in which the resin is sprayed directly onto the sedimentary surface. Penetration of pore-spaces is accomplished by capillary action and surface tension. Consequently, the aerosol-resin method is less effective in water-saturated than in dry sediments. Moreover, peels produced in this way are rather fragile and a generator or cylinder of compressed air is required to power a garden-type sprayer.

We describe here an adaptation of McMullen and Allen's (1964) aerosol method that uses plastic resins available from local suppliers and less expensive and more portable equipment that can be operated by one person in the field. The basic procedure is: (1) to scrape the outcrop clean of weathered material and make it as smooth as possible; (2) to spray the surface with a dilute mixture of resin in order to stabilize it; and then (3) to paint additional resin onto the surface with a small brush, both to achieve greater penetration of the sediments and to affix a backing cloth. During our summer-time tests of the method, the peels usually cured sufficiently a few hours or in half a day to be removed and transported with only a corrugated cardboard support. For a similar method based on lacquer, see Schmieja (1982).

#### CHEMICALS

Unsaturated polyester resins are readily available from local retailers, and any brand marketed as polyester gel-coat for use on fiberglass boat hulls will suffice for making sedimentary peels. The resin should be unpigmented. McMullen and Allen (1964) recommended Bakelite and Scott Bader brand polyester resins, but these are unavailable in the U.S. We used types 4116 and 4110 Laminac, manufactured by American Cyanamid. Similar resins are produced by U.S.S. Chemicals, Dow Chemical, Mobil Corporation Chemical Division, Sherwin Williams, Ashland Chemical Company Polyester Division, and Beatrice Foods Chemical Division. Because brand names and catalog numbers change quickly, the manufacturers should be consulted for current products. Typical costs of resins and other necessary chemicals are presented in Table I.

The resin must be mixed with a small amount of a catalyst-accelerator before it is applied to the sediment in order to hasten curing. We used a 1% (weight) solution of methyl ethyl ketone peroxide (MEK; also called 2-Butanone peroxide), but almost any peroxide can be used as a catalyst. MEK is a powerful oxidizer, and must be purchased from a specialty chemical supplier. However, because it is used in very small amounts, a courtesy sample from local manufacturers or laboratories is sufficient to generate many peels. In the hot summer conditions of the Atlantic Coastal Plain (25°–33°C, 75°–90°F, still and sunny), 40 drops (2 ml) of a 1% (weight) MEK solution

TABLE I

#### Chemicals and equipment

Item	Unit price (U.S.\$)	Required per batch
Unsaturated polyester resin	5 per liter	100 ml
Methyl ethyl peroxide (MEK) catalyst	11 per 100 g of 50% (weight) solution	40 drops (about 2 ml) of 1% (weight) solution
Isopropyl alcohol (IPA) thinning agent	1 per liter	10 ml
Diethylene glycol ether monoethylether (DE) cleaner	0.30 per kg	30 ml
Non-flammable aerosol propellant	5 per 13 oz. can	Adequate for 3–4 100 ml of batches of resin
Spraying apparatus with graduated reservoir for resin mixture	12	One minimum; two desirable
Other equipment:		
50 ml capacity graduated cylinder; eyedropper and bottle for MEK; stirring rod; small brush; muslin backing fabric; marker to label fabric; corrugated cardboard to support large peels during transport		

mixed with 100 ml resin in small batches worked best. Higher proportions of MEK to resin caused premature hardening and also made the equipment difficult to clean. Larger batches of the resin mixture would begin to harden before they could be applied, either by sprayer or brush.

Resin to be sprayed on the outcrop in the initial, stabilizing phase of making a peel must be mixed with a thinning agent in order to reduce the resin's high viscosity. We used isopropyl alcohol (IPA) available in drug-stores, but most glycol ethers or alcohols will do. Ten ml of IPA per 100 ml of resin worked best for the clean to silty sands, sandy silts, and clays tested. Higher proportions of IPA made the resin mixture run down the outcrop surface rather than penetrate it, and less dilute mixtures tended to clog the sprayer apparatus.

These chemicals should not be used on windy days when the spray could be blown in the face or without good ventilation. Great care must be taken to keep the catalyst MEK off skin and clothes, and it should be stored and carried separately from the other chemicals. The resin mixture can be cleaned from the equipment using IPA or the more effective solvent DE (diethylene glycol ether monoethyl ether), which is available from chemical suppliers. DE is safe for use on clothes and hands, although it will cause some chapping of the skin.

#### EQUIPMENT AND PROCEDURE

For spraying the resin, we used a plastic apparatus that snaps onto small disposable cans of non-flammable propellant (Fig. 1). Both the apparatus



Fig. 1. Snap-on plastic spraying apparatus and can of propellant used to stabilize sediment surface with a mixture of polyester resin and catalyst thinned with alcohol.

and propellant are manufactured by Crown Industrial Products Inc., marketed by the Fischer Scientific Company. The sprayer attachment comes with a graduated reservoir of translucent plastic that screws into the base of the black plastic sprayer top. Resin can be measured and mixed directly in the reservoir, eliminating the need to carry and clean a separate beaker for this purpose. An eyedropper is used to measure the MEK catalyst, and a small graduated cylinder serves for the IPA thinning agent. The spraying apparatus is easily cleaned by spraying a small amount of DE through the system, and wiping clean the delivery tube and the front of the sprayer with DE on a paper towel. We found it convenient to have two of the sprayer attachments in the field. In this way, one sprayer could be used while the other was being cleaned, and we had a back-up apparatus in case of clogging.

The aerosol propellant should be non-flammable. The 13 oz. cans of Power Pack brand fluorocarbon propellant that we used are sufficient to spray-stabilize areas of about 0.3 m<sup>2</sup> (3 ft<sup>2</sup>; applied 3–4 100 ml batches of

resin). Under sustained use, the propellant remaining in the can cools and loses power, even though the propellant is not depleted, owing to adiabatic pressure drop. This power is regained once the can is rewarmed (hand or sunshine only). Because a batch of resin can harden in the sprayer reservoir before the propellant is rejuvenated by rewarmed, it is worthwhile to have two cans of propellant to alternate when making peels larger than about 1 ft<sup>2</sup>.

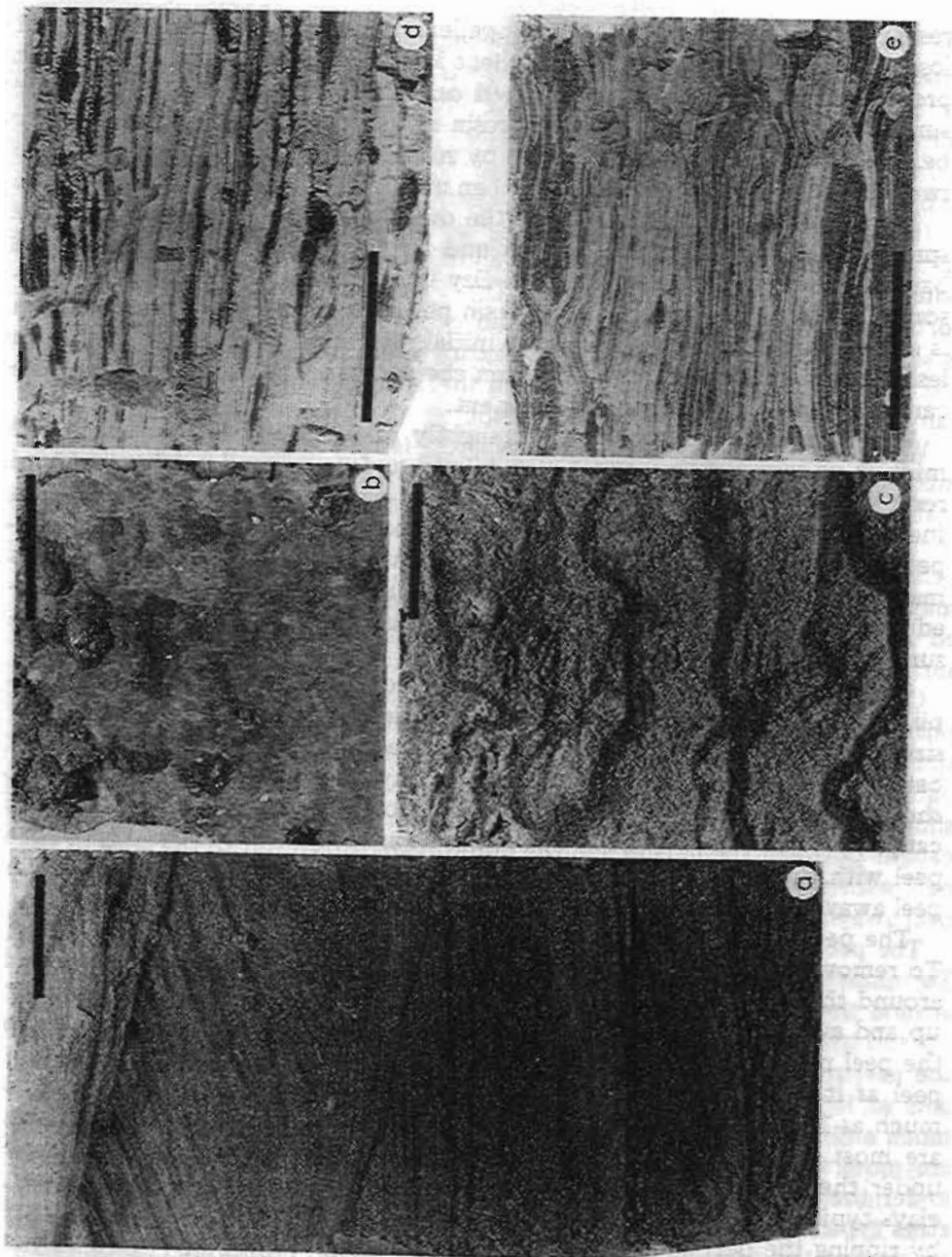
In the initial phase of stabilizing the outcrop surface, the resin should be sprayed quickly with uniform back and forth motions in as many 100 ml batches as the sediment will accept. Dry to slightly damp fine-grained well-sorted sands accept about 100 ml resin per square foot. Penetration of resin is slower in silty lithologies, so that initial saturation is often achieved with less than an entire 100 ml batch from the sprayer. The excess resin mixture can be brushed gently onto the sediment.

When the sprayed resin has set slightly (a few minutes), an unthinned mixture of resin is painted on the stabilized surface in small batches of 50 ml resin and 20 drops MEK, taking care not to disrupt the sprayed surface. An inexpensive, 2–3 cm wide natural bristle or nylon brush works well. Depending on the permeability of the sediment, several of these small batches may be necessary to fully saturate the sediment. The resin should be brushed on carefully with up and down strokes. It should not be poured onto the surface.

Once the surface sediments are saturated or near-saturated with brush-applied resin, a piece of cotton muslin trimmed slightly larger than the final size of the peel is bonded to the impregnated sediment using a final 50 ml batch of resin. The fabric backing can be any open-weave cotton cloth, but should be clean and dry. It is best labeled before attachment. Any air bubbles caught between the muslin and the outcrop are forced out to the edge of the peel with the brush. The outer edge of the muslin is left free for pulling the peel away from the outcrop.

The peels cure sufficiently in one day or less to be removed successfully. To remove peels from sandy sediments, it is helpful to first loosen sediment around the edges and then pull the lower two corners of the muslin backing up and away from the outcrop. In this way, loose sediment falls away from the peel rather than over it. Care should be taken not to bend or crease the peel as it is pulled off the outcrop. Peels of sandy sediments will have as much as 1 cm of sediment bonded to the muslin backing. If large, these peels are most safely carried on a sheet of corrugated cardboard lest they bend under their own weight. Peels of cohesive silty sediments and interbedded clays typically have little sediment attached to them. These are best removed by ripping the peel off the outcrop face in a single, fairly rapid motion like that used in removing acetate peels.

Odd clumps of sediment that stick to the peel should be picked or brushed off the surface as soon as the peel is removed from the outcrop surface. Thick peels will still be quite elastic when removed in less than one day, but are sufficiently sturdy in this state for transport. They should lie flat until



they have cured completely to a brittle stage, which may take a few days. The peels can be sprayed with several coats of acrylic resin (e.g. Krylon Crystal Clear) or shellac to further stabilize them for permanent display or storage.

## RESULTS

This adaptation of McMullen and Allen's (1964) polyester resin method gave excellent results in the entire range of unconsolidated sediments tested. These included fine- to coarse-grained clean sands, silty sands, and interbedded clays and sands, both wet and dry, from cliff exposures of the Miocene Chesapeake Group in Maryland (Kidwell, 1984). The most dramatic peels were produced from dry to moist sediments with impressive structures apparent in outcrop, such as the bedded sands and clays of Figs. 2a–e. However, the method was also successful in revealing obscure structures (e.g., small-scale bioturbation in Fig. 2b) that were not apparent in either fresh or weathered field exposures. Water was actively seeping from the sediment shown in Fig. 2b when the peel was prepared.

This method has several advantages over the techniques described by McMullen and Allen (1964) and by others for preserving sedimentary structures in unconsolidated sediments:

(1) *Low cost and ready availability of materials.* The new plastic spraying equipment, disposable propellents, and resins available today are less expensive than those advocated by McMullen and Allen (1964), and their availability from local retailers further reduces both cost and time. Total expenses for equipment are U.S. \$16 with the modified method; if two sprayers are used, the costs are \$28. This should be contrasted with equipment costs of about \$60 for a garden sprayer, compressed gas cylinder, and necessary valves and attachments required by the unmodified McMullen and Allen (1964) method. Costs of expendable supplies are also low in the method described here: less than \$2 of resin mixture and about \$2 of propellant are required per 0.2 m<sup>2</sup> (about 1 ft<sup>2</sup>) of finished peel. In addition to eliminating the need to invest in one or more cylinders for compressed gas, the disposable cans of propellant save on the expense and time required to refill the cylinders. In the study area in Maryland, refills of compressed air cost \$8 each and require a round trip of 80 km.

Fig. 2. Finished relief peels from cliff exposures of Miocene sediments, Calvert Cliffs, Maryland. Bar scale 10 cm. By brushing an unthinned resin mixture on the sediment after spraying, and bonding a cloth backing to the peel, penetration was excellent in wet and damp sediments as well as in dry. a: Wedge-shaped sets of cross- and parallel-laminated, medium- to coarse-grained moist sand; St. Marys Formation. b: Small-scale bioturbation in silty fine-grained seeping sand; dark-colored pods of sand and shell near top of peel are *Thalassinoides* burrow fills; upper Choptank Formation. c: Thin-bedded coarse-grained moist sand deformed by 3 cm-diameter burrow that extends to bottom of peel; St. Marys Formation. d and e: Irregularly interbedded laminated fine sand (dark) and clay with scour structures, burrows, and spreiten; peeled when dry; St. Marys Formation.

(2) *Practicality for field use.* Although the process is made easier and faster by an assistant, one person working alone can make the peels and can carry the equipment, supplies, and finished peels for an entire day's work. The simple and lightweight equipment make the method ideal for use in isolated areas. Like McMullen and Allen's original method, it has the advantage of taking peels from sediments in-situ, which eliminates the box-coring equipment required by some other methods, and works well on wet sediments, so that drying apparatus and vacuum conditions are unnecessary. The complete operation of making a peel, including outcrop preparation, mixing and applying the resin, and cleaning the apparatus takes less than one hour, and the peels are sufficiently sturdy to transport within a day and while still elastic. Curing in the field can be hastened by increasing the proportion of catalyst in the resin mixture. Heavy backing boards of metal or plywood, heating lamps, and special crates for transport are not needed. The ease of application, rapidity of curing, and success of the method in wet sediments thus make the method particularly valuable in situations where tides or teaching schedules limit time and budgets limit expenses.

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