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ADHESIVES AND CONSOLIDANTS IN GEOLOGICAL AND PALEONTOLOGICAL CONSERVATION: A WALL CHART

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INTRODUCTION

Geological materials, perhaps more than any other class of natural history materials, are subject to the application of various polymeric materials from field to museum to exhibition. Some common uses of polymers include field and preparation stabilization, adhesion of broken pieces, consolidation of crushed or fragile specimens, gap-filling, molding and casting.

The use of adhesives and consolidants is the most wide-spread application of polymers in geological conservation, yet the most poorly documented and most problematic. Current research may remedy some problems in geological conservation, but much remains to be done.

The nature of geological materials and their uses in research, exhibition and education has resulted in the use of a wide range of polymers. It is important to note that there is no single polymer that is universally useful for all types of specimens and all varieties of use. This chart is a quick guide to some of the most common classes of polymers.

In general, it is best to select polymers that are easy to use, are stable over time, suit the specific task at hand, and can be practically reversed at need. Other desirable characteristics include unobtrusiveness (ideally the polymer is water-clear and does not discolor over time), cost effectiveness, ease of use, and compatibility with the materials being treated.

GUIDE TO THE WALL CHART

The wall chart summarizes some of the key information about adhesives and consolidants commonly encountered in geological conservation, either in modern use or in older specimens needing attention. A list of references for further investigation is given on the back page of this Leaflet, as is a glossary of terms. The major categories included in the chart are:

- Chemical family: the general class of polymer or compound to which the materials belong.
- Chemical composition: further information as needed on the chemical structure of the materials.
- Trade name(s) and manufacturer(s): information on the common brand or trade names in the US, Canada and the UK.

- Tg (glass transition temperature): temperature at which thermoplastic substances pass from a solid or glassy stage to a plastic, flexible one. Not given for thermoset or irreversible substances.
- Reversibility and solvents: information on the practical (not ideal) reversibility of the material, and on which solvents can be used with the material.
- Historic uses and comments: quick summary of uses, characteristics, advantages and disadvantages.

HEALTH AND SAFETY

Most of the materials listed in the wall chart depend on the use of solvents to carry the polymer or to reverse a joint. The health and safety aspects of solvent use are extremely important. Most of these require the use of a fume hood in a laboratory setting. A fitted respirator with appropriate filter cartridges is highly recommended for field use of solvents.

It is important to understand the health precautions to use with all materials. For each proprietary substance, including both polymers and solvents, it is necessary to have on hand a copy of the manufacturer's official Materials Safety Data Sheet (MSDS). This should not be confused with an advertising or general information flyer from the manufacturer. The MSDS must be provided free from the manufacturer on demand; it summarizes the health risks and safety precautions which the user has a right to know.

UNIDENTIFIED ADHESIVES AND CONSOLIDANTS

Many substances are not problematic until long after they are used; problems such as shrinkage, yellowing, or other degradation may take years to develop. Unfortunately, polymer use in the past (and to some extent in the present) is poorly documented. There are some substances listed on the wall chart which are not in common use today, but which are often encountered by people working on specimens treated years ago.

It is beyond the scope of this Leaflet to describe a protocol for identifying aged and problematic consolidants and adhesives. The best approach, in the absence of documentation, is to test with minute amounts of common solvents to see which ones are effective in softening the polymer, and to consult a conservator if the material seems to be immovable and insoluble.

DEFINITIONS

Adhesive: any substance capable of bonding other substances together by surface attachment.

Catalyst: a substance that markedly speeds up the cure of an adhesive.

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ADHESIVES AND CONSOLIDANTS IN GEOLOGICAL AND PALEONTOLOGICAL CONSERVATION: A WALL CHART

CHEMICAL FAMILY	CHEMICAL COMPOSITION	TRADE NAMES AND MANUFACTURERS	T _g (°C)	REVERSIBILITY AND SOLVENTS	HISTORIC USES AND COMMENTS (A: ADHESIVE; C: CONSOLIDANT)
ACRYLIC POLYMERS (RESINS)	Methylmethacrylate (MMA), ethylmethacrylate (EMA), iso-butylmethacrylate (IBMA)	Acryloid (Paraloid) (Rohm & Haas) B72 (EMAMMA) ¹ B67 (IBMA) Lucite (Perspex) (MMA) Euvacite (DuPont) Synocrit (Cray Valley Products) Bedacryl (ICI) Planlex	40 50 -40 -40 -40 -40 -40	R medium; S: Ac, EtOH. R medium; S: W, Al, K, Gly. R medium; S: CCl ₄ S: 40% solution in X	A/C commonly used in conservation. A/C used in paleontology, fine art. A/C. Used in acid preparation as coating.
ACRYLIC DISPERSIONS OR EMULSIONS	MMA, EMA, ethylmethacrylate (EA)	Rhoplex (Primal) (Rohm & Haas) AC 33: emulsion B60A: emulsion WS 24: dispersion Lascaux: emulsion (Lascaux)	16-20 16-20 39	R medium to good in Ac. S: H ₂ O (not after set).	A/C used for bone and some wet fossil material. A/C used for bone.
ANIMAL GLUES	Complex protein preparations (bone, fish, rabbit, etc.)	Secotine Fish glue	Varies: us. low	R: varies with type, age. S: Al.	Surface A/C. Label application. Tend to yellow. Very unstable. May invite pest attack.
CELLULOSE ACETATE	Cellulose acetate/butyrate	Lapages Cement		R: limited S: Al.	A: Limited use in geology.
CELLULOSE NITRATE (CN)	Cellulose polytritate ester; plasticizers may be dibutyl phthalate, camphor, or triphenyl phosphate	Duco cement, UHU, Durofix, Ambroid, Randolph's HMG (H. Marcel Guest)	-55 -55	R limited. S: Ac, EtAc, B. R: good S: aliphatic/aromatic.	A: Not generally recommended: tends to yellow and deteriorate. Migration or volatilization of plasticizers results in severe shrinkage, potentially damaging objects. Reactive with some metals. May yellow. Maintains solubility over time if used as directed.
CYANOACRYLATES [POLYALKYL 2-CYANOACRYLATE]]	95-100% ethyl cyanoacrylate 60-100% ethyl cyanoacrylate (viscosity varies with %age of ethyl cyanoacrylate and poly(methyl methacrylate)	Hot Stuff (Satellite City) PalaoBond (Uncommon Cong) Zap (Pacer Technology): * "superglues"	Varies	R: fair to good. S: Ac, CGE Thinner R poor. S: Nitromethane (Super Solvent); acetonitrile (PB-400); diethylformamide; dimethyl sulfoxide.	A/C. Use for geological materials began in 1980s. Quick drying time; good ease of use. Bonds can be undone with solvents with difficulty; can be removed mechanically if still tacky. Problems with hardeners. Brittle failure possible. Limited use. Severe degradation under alkaline conditions. May weaken under UV. Accelerators highly unstable.
EPOXY RESINS	Epoxy resin plus hardener	Araldite (Ciba Geigy) also Araldbond, Devcon, Epo-Tek, Hxtal, Devcon		R: non-reversible. S: Epoxy disintegrators (methylene chloride and methanol mixture).	A: Used mainly in mineralogy when optical properties are important and reversibility may not be a consideration. Disintegrators unstable.

¹ Other supplied names: HMG 872 adhesive, Conservation Adhesive (after Koob)

POLY(ETHYLENE GLYCOL)	Many molecular weights. Higher numbers tend toward more waxy/solid characteristics.	Carbowax, PEG		R very limited. S: H ₂ O. Some molecular weights may be removable mechanically.	C for bone and wood. Used in preparation of damp material.
POLYURETHANE RESIN SYSTEMS		Ureol systems (Ciba Geigy)		R: non-reversible.	Little used as C; supporting material in paleontology coatings and A. Tends to hydrolyze, brown, and become insoluble.
POLY(VINYL ACETAL)		Alvar 1570 (UK, 1720 (US)		R medium to good. S: Ac, diacetone alcohol, IMS	A/C widely used in paleontology.
POLY(VINYL ACETATE) [PVAC] RESIN	vinyl acetate homopolymer	Mowilith (Hoechst) Vinac range B-15 B-25 Vinyllite (Union Carbide) AYAA AYAF AYAC Gelva	16-27 21 24 16	R medium to good. S: Ac, EtOH, T, X.	A/C. Easy to manipulate physical properties by varying solvent systems. Can be reversed as both adhesive and consolidant. Good long-term aging; not prone to cross-linking. May be incompatible with methacrylates in solution. Relatively unaffected by light.
POLY(VINYL ACETATE)-COPOLYMER EMULSION	vinyl acetate/dibutyl maleate	Vinarnul Mowilith DM427 (Hoechst) Jade (Linaco Inc. Ltd) Etvaco, Elmers, CM Bond	5-29	R poor once set. S: H ₂ O (swells); EtOH, Ac (poor)	A/C widely used for fossils. Poor solubility makes subsequent treatment of objects difficult. PVAL often used as emulsifier. Not usually recommended for any use in this field.
POLY(VINYL ALCOHOL) [PVAL]		range of suppliers		R good if not cross-linked. S: H ₂ O.	Separator, label A, surface C. Poor stability. Becomes insoluble over time.
POLY(VINYL BUTYRAL)	terpolymer of poly(vinyl butyral), poly(vinyl alcohol), and poly(vinyl acetate)	Butvar (Monsanto) B98 B76 B72 Mowital (Hoechst) B30H, B60H Rhovinal B	-65 48-55 -65	R medium to good. S: Al. S: Ac, K. R medium to good. S: Al.	A/C widely used in paleontology. Different grades have different usefulness in this field. B-76 and B-98 appear to be the most popular. Good consolidant. Does not seem to shrink or discolor over time.
POLY(VINYLBENE CHLORIDE) [PVDC]		Saran			C: bone consolidation.
SHELLAC	complex substance from insect secretions and associated plant materials.	Shellac, French polish	-40	R good unless cross-linked. S: Al unless cross-linked. Ac (fair). Very hard to remove mechanically.	Use as a geological specimen coating and consolidant began in 1860s. Darkens. Not recommended for any use in this field. Hydrolyzes. Cross-links rapidly at elevated temperatures and at room temperature.
SOLUBLE NYLON	N-methoxymethyl Nylon	Catalon (ICI) Evanide 8063 (DuPont)		R: Non-reversible. S: Al.	Widely used on stone in the 1970s; some use in paleontology. Now definitely not recommended.

SOLVENT KEY: Ac: acetone; Al: alcohols in general; B: butyl acetate; CCl₄: carbon tetrachloride; EtOH: ethanol; Gly: glycol; H₂O: water; IMS: denatured ethanol (industrial methylated spirit); K: ketones in general; MEK: methyl ethyl ketone; T: toluene; W: white spirit; X: xylene