



The Engineering Geologist



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In a review of activities of GSA over the past few years, it is interesting to note an increase in volunteer and invited papers toward practical applications of the geologic science. We in the Engineering Geology Division through interest and participation in the Division's activities have made significant contributions, but it is not time for us to sit back and relax. It would seem appropriate to remind ourselves of the need to constantly sharpen our understanding of all geologic concepts. Certainly, much can be accomplished by our daily activity. However, attendance at the annual meetings of GSA is always significant, not only as a means of developing discussion of problems in the field of engineering geology, but also as an opportunity to participate in the activities of other divisions of the Society. Advance announcements of the annual meeting in Dallas indicate an excellent program of symposia and volunteer papers and many interesting field trips.

G. Gordon Prescott  
Chairman

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1973 GSA MEETING ENGINEERING GEOLOGY DIVISION PROGRAM AND RELATED SESSIONS

MONDAY, NOVEMBER 12

Management Board Meeting
9 a.m., Room 434, Statler-Hilton Hotel

Committee on Natural Construction Materials
8 p.m., Room 437, Statler-Hilton Hotel

Symposium: *Geology and Management in the Coastal Zone: Institutional Perspectives* (volunteered papers)
8:45 a.m., Parquet Ballroom A, Convention Center

Symposium: *Geology and Management in the Coastal Zone: Area Perspectives*
1:30 p.m., Parquet Ballroom A, Convention Center

Seminar: *Hydrology in Land-Use Planning*
8 p.m., Room N233-N234, Convention Center

TUESDAY, NOVEMBER 13

Engineering Geology Division Luncheon
12 noon, Vista Room, Statler-Hilton Hotel
(The E. B. Burwell, Jr., Award will be presented to J. E. Hackett and Murray R. McComas following luncheon.)

O. E. Meinzer Symposium: *Carbonate Hydrology, Especially Texas and Mexico*
8:30 a.m., Parquet Ballroom B, Convention Center

Problems of Engineering Geology along the Mississippi River
Charles R. Kolb (organizer) and Arthur Cleaves, presiding
8:30 a.m., Room S411, Convention Center

Engineering Geology Division Symposium: *Decay of Stone and Other Natural Construction Materials*
Erhard M. Winkler (organizer) and Ronald H. Gelnett, presiding
1:30 p.m., Parquet Ballroom B, Convention Center

Environmental Geology: Land-Use Planning (volunteered papers)
1:30 p.m., Parquet Ballroom C, Convention Center

WEDNESDAY, NOVEMBER 14

Engineering Geology (volunteered papers)
Alice S. Allen and Raymond Whitla, presiding
8:30 a.m., Room N222-N223, Convention Center

Quaternary Geology and Geomorphology Division Symposium: *The Unsteady Earth*
8:30 a.m., Parquet Ballroom B, Convention Center

Environmental Geology: Geologic Hazards (volunteered papers)
1:30 p.m., Parquet Ballroom B, Convention Center

Jack Walper, Program Chairman

Chemical Preservatives for Natural Stone Annotated Bibliography

compiled by
ERHARD M. WINKLER
Notre Dame, Indiana

This short annotated bibliography gives some recent scientific references which should be helpful to the stone industry for obtaining basic information on stone preservatives currently in use, to prevent future costly mistakes.

Introduction

The rapid, visible decay of stone in urban areas has made it necessary to protect stone surfaces from premature decay; the attempt is to halt the natural process of stone decay, but we can merely slow down nature's continuous gnawing. Protective commercial chemicals have been applied since the 17th century. The heterogeneity of stone, however, does not permit a generalized panacea; the number of failures in stone preservation is greater than the number of cures. In the early days of stone treatment, the access of surface water was prevented by the application of linseed oil and hot waxes. Total sealing rarely solved the problem, as the actual travel routes for moisture within the monument or from the ground were not yet understood. Undesirable stains, efflorescence, and accelerated flaking were the result. Today, the great variety of chemicals includes sealing paints and varnishes, and silicones, resins, and other compounds designed to achieve efficient penetration.

Stone preservatives fall into two general categories, sealers and hardeners. Many modern compounds serve both functions.

Anonymous, 1950 – The weathering, preservation and maintenance of natural stone masonry (Part I). Building Research Station Digest, July, no. 20, 8 p. *Weathering and salt content discussed. Chapter on removal of soluble salts by repeated washing and soaking with clean water.*

Anonymous, 1950 – The weathering, preservation and maintenance of natural stone masonry (Part II). Building Research Station Digest, August, no. 21, 8 p. *Oil paints as effective sealants. Steam cleaning of stone with brushing is often successful. Water sprays with mounted jets successful on limestone, but some discoloring to be expected. Sandstones and rough textured granites should be cleaned with HF.*

Baer, N. S., Lewin, S. Z., 1970 – The replacement of calcite by fluorite: A kinetic study. *Am. Mineralogist*, v. 55 (3-4): 466-476. *NH₄F solution replaces calcite in proportion to F⁻ concentration and the surface area. Rate of reaction at phase boundary was only rate determining step. The reaction, in %, was fastest with travertine, followed by Indiana limestone, a calcite crystal, and marble slowest.*

Blazej, Doubrova, Rathousky, 1959 – Die Anwendung organischer Siliziumverbindungen bei der Konservierung und Restaurierung eines Teiles der Sandstein-ballustrade des Lustschloesschens im koeniglichen Garten (Balvedere, Prag) [Application of organic Si-compounds during the conservation and restoration of a part of the sandstone balustrade of the pleasure seat in the Royal Garden (Belvedere, Prague)]. *Zpravy pamatkove pece* 3-4, XIX: 69-80. *Ethyl polysilicate condenses to polysilicic acid with moisture cementing the sandstone. Impregnation and wettability is better than with K-silicate, also no introduction of new salts during ethyl polysilicate treatment.*

Bouma, A. H., 1969 – Methods for the study of sedimentary structures. Wiley Interscience, 458 p. *Pages 87 to 89 list products for impregnation methods for unconsolidated and partially consolidated sediments of various grain sizes with comparison of properties. Information appears applicable to crumbly sandstones.*

Brandt, K., 1968 – L'emploi des silicones dans le traitement des maconneries [Application of silicones in the treatment of masonries]. *Peintures, Pigments, Vermis*, v. 44 (1), p. 47 (abstract). *Silicone solutions penetrate deeply into masonry*

walls but stone retains microporosity and respiration preventing entry of rainwater.

Burgess, S. G., Schaffer, R. J., 1952 – Cleopatra's needle. *Chemistry and Industry*, October 18: 1026-1029. *London Obelisk granite surface treated with Dammar resin as sealant; monument re-treated with low melting wax (120°F) 1948 and infiltrated with blow lamp, followed by darkening of surface. New York obelisk was treated 1885 after heavy damage was inflicted by entrapped salts. Treatment was successful in both monuments.*

Caron, M. C., 1967 – Applications des resins synthetiques dans les travaux publics [Application of synthetic resins for public works]. *Annals de l'Institut Technique du Batiment et des Travaux Publics*, 235-236: 996-1016. *Epoxide and polyester resins of low viscosity (20 cP) were grouted into crumbly Nubian sandstone (at Abu Simbel [VAR]) to seal anchoring rods and cement cracks, consolidate the sandstone by grouting. Operation at Abu Simbel was successful.*

Domaslowski, Wieslaw, 1970 – L'affermissement structural des pierres avec des solutions a base de resines epoxydes [Structural strengthening of stone with solutions of epoxy resin base]. *Conserv. of Stone and Wooden Objects New York Conf.* 7-13 June 1970; *Int. Inst. f. Conserv. of Historic and Artistic Works*, p. 85-101. *Mixtures of epoxy resins with tuloene and methanol at different concentration ratios. Ratios determine both the viscosity and the time of hardening. Impregnation with a 30% solution doubled compressive strength, capillarity, resistance to freeze and thaw, etc.*

Franklin, J. A., 1969 – Rock impregnation trials using monomers, epoxide, and unsaturated polyester resins. *Jour. Sedimentary Petrology*, v. 39 (3): 1251-1253. *Excellent penetration into small pores by monomeric impregnators with maximum fluidity converting to polymers. Properties of many commercial products are compared on chart, for epoxide resins, unsaturated polyester resins, and monomers. Unsaturated polyester resins show satisfactory performance and good penetration, monomers excellent impregnation but poor dimensional stability (shrinkage cracks).*

Gauri, K. L., 1970 – Improved impregnation technique for the preservation of stone statuary. *Nature*, v. 228 (5274): 882. *Impregnation of marble and other stone with a mixture of resin and acetone 1:1 first, later increasing to 95% resin and 5% acetone. Less viscous early applications penetrate deeper while denser resin cements remain in weathered rim. Non-polymerized resins cure within stone. Admixture of silica gel to large-pored stone. Resin penetration of several cm in marbles prevented attack by CO₂ and SO₄.*

Kauffmann, J., 1960 – Corrosion et protection des pierres calcaires des monuments [Corrosion and protection of limestone monuments]. *Corrosion-Anticorrosion*, v. 8 (3): 87-95. *Bacterial attack on limestone surfaces can convert CaCO₃ to more soluble CaSO₄ or Ca(NO₃)₂. Bactericides (e.g. sulfates of Cu or Zn) eliminate such damage.*

Kieslinger, A., 1953 – Probleme des Natursteinbaues (IV) – Erfahrungen mit Steinschutzmitteln [Problems with natural dimension stone – Experience with protective chemicals]. *Steinmetz und Steinbildhauer*, 69: 76-78. *Different behavior for each stone requires testing in each case. 56 literature citations, mostly older than 1945.*

Kratz, A., 1963 – Eine neue Methode der Steinrestaurierung [A new method of stone restoration]. 1963 (1): 32-39. *Stone sculptures desalted and hardened by pumping distilled water through the sculpture under vacuum.*

Lewin, S. Z., 1966 – The preservation of natural stone, 1839-1965. An annotated bibliography. *Art and Archaeology Technical Abstracts*, v. 6 (1): 158-272. *Nearly complete account of all patents and publications.*

Lewin, S. Z., 1968 – The conservation of limestone objects and structures. *Conferences on the Weathering of Stones, Brussels 1966-67. International Council of Monuments and Sites (ICOMOS), Paris*. p. 41-64. *Ba(OH)₂·8 H₂O + 4% urea formed insoluble surface films and recrystallized less stable fine grains to insoluble BaCO₃; density and strength of stone was also improved. 42 citations of literature and patents.*

- Moncrieff, A., Hempel, K., 1970 – Work on the degeneration of sculptural stone. *Conserv. of Stone and Wooden Objects*, New York Conf. 7-13 June 1970; Int. Inst. f. Conserv. of Historic and Artistic Works. p. 103-114. *Epoxy resin, Maraset Type A 655 (Marblette Corp., Long Island, N. Y.) was applied to crumbly Carrara marble, with good penetration and color retention. Application of resin after removal of soluble salts.*
- Munnikendam, R. A., 1967 – Preliminary notes on the consolidation of porous building materials by impregnation with monomers. *Studies in Conservation*, v. 12 (4): 158-162. *Discussion of methyl methacrylate monomer which cures at room temperature to the polymer. Spray application possible unless evaporation of monomer. Reaction is reversible with acetone for temporary consolidation.*
- Munnikendam, R. A., 1970 – Acrylic monomer systems for stone impregnation. *Conserv. of Stone and Wooden Objects*, New York Conf. 7-13 June 1970; Int. Inst. f. Conserv. of Historic and Artistic Works. p. 15-18. *Considerable improvement of strength and corrosion resistance by low viscosity acrylic and methacrylic monomers (0.6 cP) applied with high reactivity peroxide and borane as initiators. This stone/polymer composite material used in stone and concrete.*
- Riederer, J., 1970 – Stone preservation in Germany. *Conserv. of Stone and Wooden Objects*, New York Conf. 7-13 June 1970; Int. Inst. f. Conserv. of Historic and Artistic Works. p. 125-134. *Choice of hardener depends on type of stone and its condition. Successful application of Fluosilicates on marbles and limestones protected by silicones, water glass, and synthetic resins. Waxes, soaps, and oils as water repellents have shown many failures.*
- Sayre, E. V., 1970 – Direct deposits of barium sulfate from homogeneous solution within porous stone. *Conserv. of Stone and Wooden Objects*, New York Conf. 7-13 June 1970; Int. Inst. f. Conserv. of Historic and Artistic Works. p. 115-117. *Treatment with BaSO₄ by introducing Ba monoesters of sulfuric acid (Ba-ethyl sulfate) for solidification of soft porous limestone for applications of large surfaces.*
- Schmidt-Thomsen, K. V., 1969 – Zum Problem der Steinzerstörung und-Konservierung [The problem of stone decay and stone conservation]. *Deutsche Kunst und Denkmalpflege*, 1969; 11-23. *Discussion of conservation methods for porous, calcareous sandstone. Best success with a mixture of 100 pts. ethyl silicate and 100 pts. tri-ethoxy silan, 70 pts. alcohol plus 1 pt. HCl as a catalyst. Poor results with K-silicate and penetration only 3-4 cm, better when diluted.*
- Stambolov, T., 1970 – Conservation of stone. *Conserv. of Stone and Wooden Objects*, New York Conf. 7-13 June 1970; Int. Inst. f. Conserv. of Historic and Artistic Works. p. 119-123. *Diluted penetrating polymer solutions in multiple applications are not satisfactory; monomers penetrate deeply. Water repellent silicones perform best. Surface sealers and coatings are dangerous.*
- Steen, C. R., 1970 – Some recent experiments in stabilizing adobe and stone. *Conserv. of Stone and Wooden Objects*, New York Conf. 7-13 June 1970; Int. Inst. f. Conserv. of Historic and Artistic Works. p. 59-64. *Polyurethane resin sprayed on adobe and crumbly sandstone with solvent (spirits, kerosene) for water repellence.*
- Torraca, G., 1970 – An international project for the study of mud-brick preservation. *Conserv. of Stone and Wooden Objects*, New York Conf. 7-13 June 1970; Int. Inst. f. Conserv. of Historic and Artistic Works. p. 47-57. *Damage on adobe structures in Iraq by surface flaking. Ethyl silicate solution applied in successive increments formed bond with outer crust preventing further flaking.*
- Wihr, R., Steenken, G., 1970 – On the preservation of monuments and works of art with silicates. *Conserv. of Stone and Wooden Objects*, New York Conf. 7-13 June 1970; Int. Inst. f. Conserv. of Historic and Artistic Works. p. 71-75. *Stone impregnation with soluble alkali silicates (Bagrat-ISO-110-clear); diluted solution for dense stone.*
- Winkler, E. M., 1956 – The effect of blood on clays. *Soil Science*, v. 82 (2): 157-164. Also: U.S. Patent 2,971,293, 1961. *Beef blood, both natural and dried water soluble, as admixture to clay or as surface paint for water repellence and strength.*

REPORT ON THE FEASIBILITY OF A MORE COHERENT NATIONAL POLICY FOR THE GOVERNANCE OF UNDERGROUND SPACE, NATIONAL ACADEMY OF SCIENCES

This report of the study group on the uses of underground space, June 1972, has been printed and distributed by the National Academy of Sciences. As stated in the foreword, "an expanding interest in tunneling and underground construction calls for solutions to problems in urban areas, such as transport, sewage, power, and communications. The competing and conflicting demands for underground space at shallow depths under large urban areas has resulted in the chaos currently existing in underground usage. It seemed that a national policy for the development and utilization of underground space is badly needed and that the National Research Council within the National Academy of Sciences was an appropriate institution in which to establish a study group to consider the feasibility of developing such a policy."

This committee was chaired by Prof. Preston Cloud, biogeologist, University of California at Santa Barbara. Members of the committee and other participants are listed in the report. Other sections of the report include rationale; recommendations; policy objectives; competitive claims on underground space; resolution of social, economic, and environmental conflicts; and an appendix which lists six examples of competition for use of underground space. The report recommends that an Ad Hoc Committee be

established within the National Research Council "charged with the responsibility of formulating policy guidelines based upon legal, economic, environmental, and social considerations."

THE ENGINEERING GEOLOGIST

Editor - Mary E. Horne

570 Beatty Road

General Analytics, Inc.

Monroeville, Pennsylvania 15146

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PUBLICATIONS FROM UTAH GEOLOGICAL AND MINERAL SURVEY

Oil and Gas Fields of Utah, 1973, Utah Geological and Mineral Survey, 103 UGS Building, University of Utah, Salt Lake City, Utah 84112.

The Utah Geological and Mineral Survey has published a new series of oil and gas field studies in Utah and is now accepting orders. Each study covers one field or area and contains a structure map, accompanied by a type log. In the larger fields one or more log sections are presented. The individual field study includes two or more pages of text material and production history information.

Maps, sections, and text material are folded into a printed envelope which may be filed individually or conveniently placed in a loose leaf binder.

The new publication series covers fields discovered and developed since 1961 when a volume of oil and gas field maps and data was published in symposium form by the Intermountain Association of Petroleum Geologists. It is intended that information on many older fields will be re-studied and updated as work on the UGMS series continues. The field study project is compiled by P. R. Peterson, Salt Lake City consulting geologist.

The first 12 studies and their prices are listed below (add 10% mailing charge):

| No. | Field | County | Price |
|-----|----------------------------|---------------|--------|
| 1 | Pariette | Uintah | \$1.00 |
| 2 | Agate | Grand | 1.00 |
| 3 | Grassy Trail Creek | Carbon, Emery | 1.00 |
| 4 | Salt Wash | Grand | 1.00 |
| 5 | Bridger Lake | Summit | 1.50 |
| 6 | Horseshoe Bend | Uintah | 1.50 |
| 7 | Upper Valley | Garfield | 1.50 |
| 8 | Castle Peak—Monument Butte | Duchesne | 1.50 |
| 9 | Fence Canyon | Uintah, Grand | 1.00 |
| 10 | Cedar Rim | Duchesne | 1.00 |
| 11 | Flat Rock | Uintah | 1.00 |
| 12 | Bluebell | Duchesne | 2.00 |

Geology and Distresses of Desert Mountain, Utah, 1973, Utah Geological and Mineral Survey, Special Studies No. 42, \$1.65 (mailed) or \$1.50 over-the-counter, 103 UGS Building, University of Utah, Salt Lake City, Utah 84112

The study of the Desert Mountain area in Juab County, about 24 miles west of Jericho and about 35 miles north of Delta, was

conducted by D. C. Rees, geologist, American Smelting and Refining Company; M. P. Erickson, associate professor, Department of Geological and Geophysical Sciences, University of Utah; and J. A. Whelan, research geologist, Utah Geological and Mineral Survey, and professor of geological and geophysical sciences, University of Utah.

The report covers stratigraphy of the area and a discussion of the Precambrian, Ordovician, and Quaternary Systems of the Desert Mountain vicinity. Igneous rocks as well as intrusive and extrusive rocks are described. The authors also detail the geologic structure of the area, the hydrothermal alteration, and the economic geology of the region. The study includes six figures of geologic illustrations and a map of the Desert Mountain area.

GSA ANNOUNCES NEW PUBLICATION

Geology has been conceived to answer today's increasing need for rapid dissemination of research information. It has been designed to emphasize current awareness by quick publication — eight weeks from acceptance of a manuscript. It will bridge the gap between the completely informal, gray literature of preprints, word-of-mouth communication, and conversations or presentations at meetings, and the permanently archived, formal publications, such as the *Bulletin* and *Memoirs*.

Much of the material appropriate for the contents of *Geology* has a very short scientific half-life, and either completes in a few years its task of stimulating further thought or research or is replaced by more complete and formal publication. During this period, however, the magazine performs a major function of replacing the ephemeral and informal sources of information.

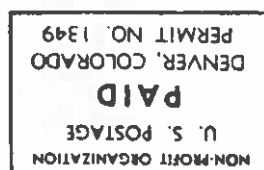
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For more information, write to GSA Headquarters for the leaflet "Information for Contributors to *Geology*."

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3300 Penrose Place, Boulder, Colorado 80301

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