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Current Comments®

The 1981 Geosciences Articles Most Cited from 1981 through 1983

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Over the years, we have published numerous essays examining papers that become highly cited shortly after publication. Presumably, the immediate impact of these papers points to "where the action is." In these studies, however, the life sciences usually dominate, especially such fields as biochemistry, immunology, and molecular biology. In separate studies of the physical sciences, theoretical and experimental particle physics and quantum field theory papers usually predominate. Other fields, such as botany, mathematics, or geosciences, may be underrepresented.

Various factors account for this underrepresentation. In general, the number of citations a paper in a given field is "eligible" to receive depends on the size of that field's literature. Another key factor is the number of references cited in the average paper. For example, the average biochemistry paper cites twice as many references as the average mathematics paper. Thus, a biochemical article has twice the chance of being cited as does a mathematical article. The prolific output of papers by biochemists increases the probability that their papers will dominate a list based on absolute counts. So it would be ludicrous to make direct comparisons between fields without "normalizing" for these variances.

By focusing on selected portions of ISI® 's data base, however, we can identify key articles from fields that would not otherwise turn up. For example, we recently identified the 44 most-cited entomology papers from a list of 36 core journals.[1] Papers from such small fields ordinarily do not achieve the required citation threshold in multidisciplinary studies based on the entire *Science Citation Index®* (*SCI®*). For similar reasons, we used the *CompuMath Citation Index®* to identify 100 highly cited articles in pure and applied mathematics and computer science.[2] By a similar approach, we have now identified geosciences articles published in 1981 which were highly cited from 1981 to 1983.

Data for this essay are from *ISI/GeoSciTech™*, our online data base for the earth sciences. *ISI/GeoSciTech* includes petroleum science, geochemistry and geophysics, oceanography, metallurgy, mining, meteorology, and many other disciplines related to the Earth's environment.[3]

Each year, *ISI/GeoSciTech* comprehensively indexes more than 400 "core" earth sciences journals. By various selection routines, articles from another 1,500 journals are indexed. Potentially, articles could also be drawn from the over 3,300 publications covered in *SCI*, as well as another 2,700 from the *Social Sciences Citation Index®* (*SSCI®*) and the *Arts & Humanities Citation Index™* (*A&HCI™*) data bases. Items from these journals are automatically indexed if they meet the requirements of the selection algorithm. For example, a current article is selected if it cites two or more articles from core journals. But each automatically selected item is then reviewed by our editors for its relevance to the geosciences.

The present study is based on *ISI/GeoSciTech* data from 1981 through 1983. This includes 161,000 articles and the 3,000,000 references they cited. About 75 percent, or 120,000, of the articles were published in the fully covered core journals. The remaining 25 percent, or about 41,000 articles, were published in one of the selectively covered journals. Many of these noncore articles were from journals in the astrosciences, crystallography, ecology, and materials science. Consequently, a significant number of the papers identified below come from these journals.

Table 1 includes the 99 papers we identified. They are listed in alphabetic order by first author. Each of the articles in this study received at least 25 citations. Had we lowered the threshold to 24, another 16 papers would have been listed. The number of times each paper was cited is followed by complete bibliographic information, including institutional affiliations. The average paper received 37 citations—4.5 in 1981, 13.9 in 1982, and 18.6 in 1983. The most-cited paper received 136 cites in this three-year period.

Since most of the 4,000,000 papers and books cited each year in *SCI* receive only a few citations, the papers in this study are clearly above average in their impact. We do not claim that these papers represent the "best" or most original geosciences research. Nor is the inclusion of the citation counts meant to suggest that one paper is "better" than another. These papers identify emerging research areas or techniques. Based on experience, there is a strong chance that many will prove to be "important" in the future. But the integration of most new ideas and methods in the earth sciences is relatively slow. It is not unlikely that future analyses will reveal other 1981 papers that subsequently prove to be heavily cited.

Recently, we clustered *SCI* and identified the most active research fronts. Briefly, a research front is established by identifying a group of current papers that collectively cite a cluster of earlier, "core" papers in a specialty. These co-citation clustering procedures have been described previously.[4] Our work with *SCI* research fronts is an extension of those procedures. We expect to report our findings in more detail later. In the meantime, we found that 48 papers in Table 1 are core articles in these 1981, 1982, and 1983 research fronts. The appropriate code numbers follow each reference. Table 2 lists the titles of these research fronts, the number of papers from this study that are core to each one, and the total number of each research front's core papers.

Table 3 shows the number of authors listed on the papers in this study. All but 17 papers were multiauthor works, with nine papers listing ten or more authors.

Forty-six authors appear on more than one paper in Table 1. Thirty-nine authors were listed on two papers each. Seven have three papers each: D.J. DePaolo, R. Hanel, V.G. Kunde, W. Maguire, P.H. Reiff, R.E. Samuelson, and R.W. Spiro.

Table 4 lists the 30 journals in which the geosciences papers were published. The three editions of the *Journal of Geophysical Research* (32 papers) and *Science* (19) account for more than half of the papers. The 51 papers in these two journals received over 2,000 citations, or 55 percent of the 3,662 cites to the 99 articles in this study. Thus, as expected, a

Table 1: The 1981 geosciences articles most cited in 1981-1983, *ISI/GeoSciTech*™ , in alphabetic order by first author. Code numbers indicate the ISI® research front specialties for which these are core papers. A = 1981 citations. B = 1982 citations. C = 1983 citations. D = total citations. E = bibliographic data.

A	B	C	D	E
3	13	21	37	**Akasofu S-I.** Energy coupling between the solar wind and the magnetosphere. *Space Sci. Rev.* 28:121-90, 1981. Univ. Alaska, Geophys. Inst., Fairbanks, AK. 83-0390
1	7	20	28	**Angell J K.** Comparison of variations in atmospheric quantities with sea surface temperature variations in the equatorial eastern Pacific. *Mon. Weather Rev.* 109:230-43, 1981. NOAA, Air Resources Labs., Silver Spring, MD; CSIRO, Div. Atmos. Phys., Victoria, Australia. 83-0958
10	7	12	29	**Arnold F, Henschen G & Ferguson E E.** Mass spectrometric measurements of fractional ion abundances in the stratosphere—positive ions. *Planet. Space Sci.* 29:185-93, 1981. Max Planck Inst. Nucl. Phys., Heidelberg, FRG.
2	6	17	25	**Atlas E & Giam C S.** Global transport of organic pollutants: ambient concentrations in the remote marine atmosphere. *Science* 211:163-5, 1981. Texas A & M Univ., Chem. Dept., College Station, TX.
7	20	25	52	**Bagenal F & Sullivan J D.** Direct plasma measurements in the Io torus and inner magnetosphere of Jupiter. *J. Geophys. Res.—Space Phys.* 86:8447-66, 1981. Mass. Inst. Technol., Ctr. Space Res., Cambridge, MA. 83-1538
2	12	12	26	**Baker D N, Hones E W, Payne J B & Feldman W C.** A high time resolution study of interplanetary parameter correlations with AE. *Geophys. Res. Lett.* 8:179-82, 1981. Univ. California, Los Alamos Sci. Lab., Los Alamos, NM.
3	13	14	30	**Balistrieri L, Brewer P G & Murray J W.** Scavenging residence times of trace metals and surface chemistry of sinking particles in the deep ocean. *Deep-Sea Res. Pt. A—Oceanog. Res.* 28:101-21, 1981. Woods Hole Oceanogr. Inst., Woods Hole, MA; Univ. Washington, Dept. Oceanogr., Seattle, WA.
3	11	11	25	**Balluffi R W & Cahn J W.** Mechanism for diffusion induced grain boundary migration. *Acta Met.* 29:493-500, 1981. Mass. Inst. Technol., Dept. Mater. Sci. Eng., Cambridge, MA; Natl. Bur. Stand., Ctr. Mater. Sci., Washington, DC. 83-1708
10	7	11	28	**Barrie L A, Hoff R M & Daggupaty S M.** The influence of mid-latitudinal pollution sources on haze in the Canadian Arctic. *Atmos. Environ.* 15:1407-19, 1981. Atmos. Environ. Serv., Toronto, Canada.
0	11	15	26	**Ben-Avraham Z, Nur A, Jones D & Cox A.** Continental accretion: from oceanic plateaus to allochthonous terranes. *Science* 213:47-54, 1981. Stanford Univ., Dept. Geophys., Stanford; US Geol. Survey, Menlo Park, CA. 83-1145
2	9	18	29	**Benjamin M M & Leckie J O.** Multiple-site adsorption of Cd, Cu, Zn, and Pb on amorphous iron oxyhydroxide. *J. Colloid Interface Sci.* 79:209-21, 1981. Univ. Washington, Seattle, WA; Stanford Univ., Stanford, CA. 83-1353
13	6	8	27	**Boudier F & Coleman R G.** Cross section through the peridotite in the Samail ophiolite, Southeastern Oman Mountains. *J. Geophys. Res.* 86:2573-92, 1981. Univ. Nantes, Tectonophys. Lab., Nantes, France; US Geol. Survey, Menlo Park, CA.
10	17	22	49	**Bridge H S, Belcher J W, Lazarus A J, Olbert S, Sullivan J D, Bagenal F, Gazis P R, Hartle R E, Ogilvie K W, Scudder J D, Sittler E C, Eviatar A, Siscoe G L, Goertz C K & Vasyliunas V M.** Plasma observations near Saturn: initial results from Voyager 1. *Science* 212:217-24, 1981. Mass. Inst. Technol., Ctr. Space Res. & Dept. Phys., Cambridge, MA; NASA/Goddard Space Flight Ctr., Lab. Planet. Atmos. & Lab. Extraterrest. Phys., Greenbelt, MD; Univ. California, Dept. Atmos. Sci., Los Angeles, CA; Max Planck Inst. Aeronom., Katlenburg-Lindau, FRG; Univ. Iowa, Iowa City, IA. 82-1234
16	24	25	65	**Broadfoot A L, Sandel B R, Shemansky D E, Holberg J B, Smith G R, Strobel D F, McConnell J C, Kumar S, Hunten D M, Atreya S K, Donahue T M, Moos H W, Bertaux J L, Blamont J E, Pomphrey R B & Linick S.** Extreme ultraviolet observations from Voyager 1 encounter with Saturn. *Science* 212:206-11, 1981. Univ. S. California, Earth Space Sci. Inst.; Univ. Arizona, Tucson, AZ; Naval Res. Lab., Washington, DC; York Univ., Toronto, Canada; Univ. S. California, Los Angeles; Jet Propulsion Lab., Pasadena, CA; Univ. Michigan, Ann Arbor, MI; Johns Hopkins Univ., Baltimore, MD; CNRS, Serv. Aeronom., Verrieres-le-Buisson, France. 83-3458; 82-1234
7	12	10	29	**Broadfoot A L, Sandel B R, Shemansky D E, McConnell J C, Smith G R, Holberg J B, Atreya S K, Donahue T M, Strobel D F & Bertaux J L.** Overview of the Voyager ultraviolet spectrometry results through Jupiter encounter. *J. Geophys. Res.—Space Phys.* 86:8259-84, 1981. Univ. S. California, Earth Space Sci. Inst., Tucson, AZ; Univ. Michigan, Ann Arbor, MI; Naval Res. Lab., Washington, DC; CNRS, Serv. Aeronom., Verrieres-le-Buisson, France.

A	B	C	D	E
6	14	11	31	**Brown R A.** The Jupiter hot plasma torus: observed electron temperature and energy flows. *Astrophys. J.* 244:1072-80, 1981. Univ. Arizona, Lunar Planet. Lab., Tucson, AZ.
0	3	24	27	**Carlson R W, Lugmair G W & MacDougall J D.** Columbia River volcanism: the question of mantle heterogeneity or crustal contamination. *Geochim. Cosmochim. Acta* 45:2483-99, 1981. Univ. California, San Diego, Scripps Inst. Oceanogr., La Jolla, CA. 83-4040
7	10	9	26	**Cavanaugh C M, Gardiner S L, Jones M L, Jannasch H W & Waterbury J B.** Prokaryotic cells in the hydrothermal vent tube worm *Riftia pachyptila* Jones: possible chemoautotrophic symbionts. *Science* 213:340-2, 1981. Harvard Univ., Museum Compar. Zool., Cambridge; Woods Hole Oceanogr. Inst., Woods Hole, MA; Smithsonian Inst., Natl. Museum Nat. Hist., Washington, DC.
0	16	16	32	**Chase C G.** Oceanic island Pb: two-stage histories and mantle evolution. *Earth Planet. Sci. Lett.* 52:277-84, 1981. Univ. Minnesota, Dept. Geol. Geophys., Minneapolis, MN. 82-0401
3	5	20	28	**Cheney R E & Marsh J G.** Seasat altimeter observations of dynamic topography in the Gulf Stream region. *J. Geophys. Res.—Ocean. Atmos.* 86:473-83, 1981. NASA/Goddard Space Flight Ctr., Geodynam. Branch, Greenbelt, MD.
1	9	16	26	**Coffey M T & Mankin W G.** Simultaneous spectroscopic determination of the latitudinal, seasonal, and diurnal variability of stratospheric N_2O, NO, NO_2, and HNO_3. *J. Geophys. Res.—Ocean. Atmos.* 86:7331-41, 1981. Natl. Ctr. Atmos. Res., Boulder; Univ. Denver, Dept. Phys., Denver, CO. 83-4567
0	10	16	26	**Cook F A, Brown L D, Kaufman S, Oliver J E & Petersen T A.** COCORP seismic profiling of the Appalachian orogen beneath the Coastal Plain of Georgia. *Geol. Soc. Amer. Bull. Pt. 1* 92:738-48, 1981. Cornell Univ., Dept. Geol. Sci., Ithaca, NY.
3	10	13	26	**DePaolo D J.** Nd isotopic studies: some new perspectives on earth structure and evolution. *Eos* 62:137-40, 1981. Univ. California, Dept. Earth Space Sci., Los Angeles, CA.
2	7	17	26	**DePaolo D J.** Neodymium isotopes in the Colorado Front Range and crust-mantle evolution in the Proterozoic. *Nature* 291:193-6, 1981. Univ. California, Dept. Earth Space Sci., Los Angeles, CA.
2	17	28	47	**DePaolo D J.** Trace element and isotopic effects of combined wallrock assimilation and fractional crystallization. *Earth Planet. Sci. Lett.* 53:189-202, 1981. Univ. California, Dept. Earth Space Sci., Los Angeles, CA. 82-1169
5	17	16	38	**Desch M D & Kaiser M L.** Voyager measurement of the rotation period of Saturn's magnetic field. *Geophys. Res. Lett.* 8:253-6, 1981. NASA/Goddard Space Flight Ctr., Lab. Extraterr. Phys., Greenbelt, MD. 83-3458; 82-1234
1	12	24	37	**Dickinson R E, Ridley E C & Roble R G.** A three-dimensional general circulation model of the thermosphere. *J. Geophys. Res.—Space Phys.* 86:1499-512, 1981. Natl. Ctr. Atmos. Res., Boulder, CO. 83-0390
0	19	20	39	**Dresselhaus M S & Dresselhaus G.** Intercalation compounds of graphite. *Advan. Phys.* 30:139-326, 1981. Mass. Inst. Technol., Cambridge, MA. 83-4677
7	14	15	36	**Dunkerton T, Hsu C-P F & McIntyre M E.** Some Eulerian and Lagrangian diagnostics for a model stratospheric warming. *J. Atmos. Sci.* 38:819-43, 1981. Univ. Washington, Dept. Atmos. Sci., Seattle, WA.
0	11	17	28	**Dusenbery P B & Lyons L R.** Generation of ion-conic distribution by upgoing ionospheric electrons. *J. Geophys. Res.—Space Phys.* 86:7627-38, 1981. NOAA/ERL, Space Environ. Lab., Boulder, CO.
2	30	47	79	**Dziewonski A M & Anderson D L.** Preliminary reference Earth model. *Phys. Earth Planet. Interiors* 25:297-356, 1981. Harvard Univ., Dept. Geol. Sci., Cambridge, MA; Calif. Inst. Technol., Seismol. Lab., Pasadena, CA. 83-0408; 83-1921
3	10	14	27	**Dziewonski A M, Chou T-A & Woodhouse J H.** Determination of earthquake source parameters from waveform data for studies of global and regional seismicity. *J. Geophys. Res.* 86:2825-52, 1981. Harvard Univ., Dept. Geol. Sci., Cambridge, MA.
14	18	30	62	**Gorney D J, Clarke A, Croley D, Fennell J, Luhmann J & Mizera P.** The distribution of ion beams and conics below 8000 km. *J. Geophys. Res.—Space Phys.* 86:83-9, 1981. Aerospace Corp., Space Sci. Lab., Los Angeles, CA. 83-0390; 82-1086
8	14	15	37	**Gregory R T & Taylor H P.** An oxygen isotope profile in a section of cretaceous oceanic crust, Samail ophiolite, Oman: evidence for δ^{18} O buffering of the oceans by deep (> 5 km) seawater-hydrothermal circulation at mid-ocean ridges. *J. Geophys. Res.* 86:2737-55, 1981. Calif. Inst. Technol., Div. Geol. Planet. Sci., Pasadena, CA.
11	12	17	40	**Gurnett D A, Kurth W S & Scarf F L.** Plasma waves near Saturn: initial results from Voyager 1. *Science* 212:235-9, 1981. Univ. Iowa, Dept. Phys. Astron., Iowa City, IA; TRW Defense Space Syst. Group, Space Sci. Dept., Redondo Beach, CA.

A	B	C	D	E
13	40	34	87	**Hanel R, Conrath B, Flasar F M, Kunde V, Maguire W, Pearl J, Pirraglia J, Samuelson R, Herath L, Allison M, Cruikshank D, Gautier D, Gierasch P, Horn L, Koppany R & Ponnamperuma C.** Orbits of the small satellites of Saturn. *Science* 212:192-200, 1981. NASA/Goddard Space Flight Ctr., Greenbelt; Univ. Maryland, College Park, MD; Rice Univ., Houston, TX; Univ. Hawaii, Honolulu, HI; Paris Observ., Meudon, France; Cornell Univ., Ithaca, NY; Jet Propulsion Lab., Pasadena, CA. 83-3458; 82-1234
2	25	44	71	**Hansen J, Johnson D, Lacis A, Lebedeff S, Lee P, Rind D & Russell G.** Climate impact of increasing atmospheric carbon dioxide. *Science* 213:957-66, 1981. NASA/Goddard Space Flight Ctr., Greenbelt, MD; Columbia Univ.; Goddard Inst. Space Stud., New York, NY. 83-5753; 82-2384
6	22	19	47	**Harel M, Wolf R A, Reiff P H, Spiro R W, Burke W J, Rich F J & Smiddy M.** Quantitative simulation of a magnetospheric substorm. 1. Model logic and overview. *J. Geophys. Res.—Space Phys.* 86:2217-41, 1981. Rice Univ., Dept. Space Phys. Astron., Houston, TX; Regis Coll. Res. Ctr., Weston; Hanscom Air Force Base, Air Force Geophys. Lab., Bedford, MA. 83-0390; 82-0331
4	15	16	35	**Harel M, Wolf R A, Spiro R W, Reiff P H, Chen C-K, Burke W J, Rich F J & Smiddy M.** Quantitative simulation of a magnetospheric substorm. 2. Comparison with observations. *J. Geophys. Res.—Space Phys.* 86:2242-60, 1981. Rice Univ., Dept. Space Phys. Astron., Houston, TX; Regis Coll. Res. Ctr., Weston; Hanscom Air Force Base, Air Force Geophys. Lab., Bedford, MA.
1	15	22	38	**Haymon R M & Kastner M.** Hot spring deposits on the East Pacific Rise at 21 N: preliminary description of mineralogy and genesis. *Earth Planet. Sci. Lett.* 53:363-81, 1981. Univ. California, San Diego, Scripps Inst. Oceanogr., La Jolla, CA. 83-0867
1	7	34	42	**Hildreth W.** Gradients in silicic magma chambers: implications for lithospheric magmatism. *J. Geophys. Res.* 86:10153-92, 1981. US Geol. Survey, Menlo Park, CA. 83-1213
4	13	18	35	**Hoppe M M, Russell C T, Frank L A, Eastman T E & Greenstadt E W.** Upstream hydromagnetic waves and their association with backstreaming ion populations: ISEE 1 and 2 observations. *J. Geophys. Res.—Space Phys.* 86:4471-92, 1981. Univ. California, Inst. Geophys. Planet. Phys., Los Angeles; TRW Defense Space Syst. Group, Space Sci. Dept., Redondo Beach, CA; Univ. Iowa, Dept. Phys. Astron., Iowa City, IA.
12	8	14	34	**Hopson C A, Coleman R G, Gregory R T, Pallister J S & Bailey E H.** Geologic section through the Samail ophiolite and associated rocks along a Muscat-Ibra transect, Southeastern Oman Mountains. *J. Geophys. Res.* 86:2527-44, 1981. Univ. California, Santa Barbara; US Geol. Survey, Menlo Park; Calif. Inst. Technol., Pasadena, CA.
8	32	46	86	**Horel J D & Wallace J M.** Planetary-scale atmospheric phenomena associated with the Southern Oscillation. *Mon. Weather Rev.* 109:813-29, 1981. Univ. Washington, Dept. Atmos. Sci., Seattle, WA. 83-0958; 82-1054
5	24	30	59	**Hoskins B J & Karoly D J.** The steady linear response of a spherical atmosphere to thermal and orographic forcing. *J. Atmos. Sci.* 38:1179-96, 1981. Univ. Reading, UK Univs. Atmos. Modell. Group & Dept. Meteorol., Reading, UK. 83-0958; 82-1054
3	13	14	30	**Kamide Y, Richmond A D & Matsushita S.** Estimation of ionospheric electric fields, ionospheric currents, and field-aligned currents from ground magnetic records. *J. Geophys. Res.—Space Phys.* 86:801-13, 1981. Kyoto Sangyo (Indust.) Univ., Kyoto, Japan; NOAA Space Environ. Lab.; NCAR High Altitude Observ., Boulder, CO.
1	16	10	27	**Kanamori H & Given J W.** Use of long-period surface waves for rapid determination of earthquake-source parameters. *Phys. Earth Planet. Interiors* 27:8-31, 1981. Calif. Inst. Technol., Seismol. Lab., Pasadena, CA.
8	7	13	28	**Kley D, Drummond J W, McFarland M & Liu S C.** Tropospheric profiles of NO_x. *J. Geophys. Res.—Ocean. Atmos.* 86:3153-61, 1981. Natl. Ocean. Atmos. Admin. (NOAA), Aeronom. Lab., Boulder, CO.
3	12	15	30	**Krimigis S M, Armstrong T P, Axford W I, Bostrom C O, Gloeckler G, Keath E P, Lanzerotti L J, Carbary J F, Hamilton D C & Roelof E C.** Low-energy charged particles in Saturn's magnetosphere: results from Voyager 1. *Science* 212:225-31, 1981. Johns Hopkins Univ., Appl. Phys. Lab., Laurel; Univ. Maryland, Dept. Phys. Astron., College Park, MD; Univ. Kansas, Dept. Phys., Lawrence, KA; Max Planck Inst. Aeronom., Katlenburg-Lindau, FRG; Bell Labs., Murray Hill, NJ.
9	7	15	31	**Krimigis S M, Carbary J F, Keath E P, Bostrom C O, Axford W I, Gloeckler G, Lanzerotti L J & Armstrong T P.** Characteristics of hot plasma in the Jovian magnetosphere: results from the Voyager spacecraft. *J. Geophys. Res.—Space Phys.* 86:8227-57, 1981. Johns Hopkins Univ., Appl. Phys. Lab., Laurel; Univ. Maryland, Dept. Phys. Astron., College Park, MD; Max Planck Inst. Aeronom., Katlenburg-

A	B	C	D	E
				Lindau, FRG; Bell Labs., Murray Hill, NJ; Univ. Kansas, Dept. Phys., Lawrence, KS.
0	8	17	25	**Kukla G & Gavin J.** Summer ice and carbon dioxide. *Science* 214:497-503, 1981. Columbia Univ., Lamont-Doherty Geol. Observ., Palisades, NY.
1	7	19	27	**Kunde V G, Aikin A C, Hanel R A, Jennings D E, Maguire W C & Samuelson R E.** C_4H_2, HC_3N and C_2N_2 in Titan's atmosphere. *Nature* 292:686-8, 1981. NASA/Goddard Space Flight Ctr., Greenbelt, MD.
1	6	20	27	**Lang J K, Baer Y & Cox P A.** Study of the 4f and valence band density of states in rare-earth metals: II. Experiment and results. *J. Phys. F—Metal Phys.* 11:121-38, 1981. Swiss Fed. Inst. Technol., Lab. Solid State Phys., Zurich, Switzerland; Oxford Univ., Dept. Inorg. Chem., Oxford, UK. 82-0411
0	7	28	35	**Lawrence J M, Riseborough P S & Parks R D.** Valence fluctuation phenomena. *Rep. Progr. Phys.* 44:1-84, 1981. Univ. California, Phys. Dept., Irvine, CA; Polytech. Inst. New York, Phys. Dept., New York, NY. 82-0412
5	3	23	31	**Lee T N, Atkinson L P & Legeckis R.** Observations of a Gulf Stream frontal eddy on the Georgia continental shelf, April 1977. *Deep-Sea Res. Pt. A—Oceanog. Res.* 28:347-78, 1981. Univ. Miami, Rosentiel Sch. Marine Atmos. Sci., Miami, FL; Skidaway Inst. Oceanogr., Savannah, GA; Natl. Ocean. Atmos. Admin. (NOAA), Natl. Environ. Satellite Serv., Washington, DC.
1	17	17	35	**Le Pichon X & Sibuet J-C.** Passive margins: a model of formation. *J. Geophys. Res.* 86:3708-20, 1981. Univ. Paris VI, Geodynam. Lab., Paris; Ctr. Oceanogr. Bretagne, Brest, France. 83-1537
0	17	21	38	**Lindzen R S.** Turbulence and stress owing to gravity wave and tidal breakdown. *J. Geophys. Res.—Ocean. Atmos.* 86:9707-14, 1981. Naval Res. Lab., Washington, DC and Harvard Univ., Ctr. Earth Planet. Phys., Cambridge, MA. 83-0924
3	17	37	57	**Logan J A, Prather M J, Wofsy S C & McElroy M B.** Tropospheric chemistry: a global perspective. *J. Geophys. Res.—Ocean. Atmos.* 86:7210-54, 1981. Harvard Univ., Ctr. Earth Planet. Phys., Cambridge, MA. 83-8298
1	13	24	38	**Lowrie W & Alvarez W.** One hundred million years of geomagnetic polarity history. *Geology* 9:392-7, 1981. Inst. Geophys., Zurich, Switzerland; Univ. California, Dept. Geol. Geophys., Berkeley, CA. 83-0687
19	21	21	61	**Ness N F, Acuna M H, Lepping R P, Connerney J E P, Behannon K W, Burlaga L F & Neubauer F M.** Magnetic field studies by Voyager 1: preliminary results at Saturn. *Science* 212:211-7, 1981. NASA/Goddard Space Flight Ctr., Lab. Extraterr. Phys., Greenbelt, MD; Tech. Univ., Braunschweig, FRG. 82-1234
3	11	18	32	**North G R, Cahalan R F & Coakley J A.** Energy balance climate models. *Rev. Geophys. Space Phys.* 19:91-121, 1981. NASA/Goddard Space Flight Ctr., Lab. Atmos. Sci., Greenbelt, MD; Natl. Ctr. Atmos. Res., Boulder, CO.
0	10	16	26	**O'Hara M J & Mathews R E.** Geochemical evolution in an advancing, periodically replenished, periodically tapped, continuously fractionated magma chamber. *J. Geol. Soc. London* 138:237-77, 1981. Univ. Wales, Univ. Coll. Wales, Aberystwyth, UK.
1	5	21	27	**Okuda H & Ashour-Abdalla M.** Formation of a conical distribution and intense ion heating in the presence of hydrogen cyclotron waves. *Geophys. Res. Lett.* 8:811-4, 1981. Univ. California, Dept. Phys. & Inst. Geophys. Planet. Phys., Los Angeles, CA.
12	13	18	43	**Pallister J S & Hopson C A.** Samail ophiolite plutonic suite: field relations, phase variation, cryptic variation and layering, and a model of a spreading ridge magma chamber. *J. Geophys. Res.* 86:2593-644, 1981. Univ. California, Dept. Geol. Sci., Santa Barbara, CA.
7	9	14	30	**Palmer T N.** Diagnostic study of a wavenumber-2 stratospheric sudden warming in a transformed Eulerian-mean formalism. *J. Atmos. Sci.* 38:844-55, 1981. Meteorol. Off., Bracknell, UK.
6	12	11	29	**Phillips R J, Kaula W M, McGill G E & Malin M C.** Tectonics and evolution of Venus. *Science* 212:879-87, 1981. Lunar Planet. Inst., Houston, TX; Univ. California, Dept. Earth Space Sci., Los Angeles, CA; Univ. Massachusetts, Dept. Geol. Geogr., Amherst, MA; Arizona State Univ., Dept. Geol., Tempe, AZ.
0	13	17	30	**Ramanathan V.** The role of ocean-atmosphere interactions in the CO_2 climate problem. *J. Atmos. Sci.* 38:918-30, 1981. Natl. Ctr. Atmos. Res., Boulder, CO. 83-5753
2	14	10	26	**Rasmussen R A & Khalil M A K.** Atmospheric methane (CH_4): trends and seasonal cycles. *J. Geophys. Res.—Ocean. Atmos.* 86:9826-32, 1981. Oregon Grad. Ctr., Dept. Environ. Sci., Beaverton, OR. 83-8298
7	6	18	31	**Rasmussen R A, Khalil M A K & Dalluge R W.** Atmospheric trace gases in Antarctica. *Science* 211:285-7, 1981. Oregon Grad. Ctr., Dept. Environ. Sci., Beaverton, OR.

A	B	C	D	E
0	10	26	36	**Reiff P H, Spiro R W & Hill T W.** Dependence of polar cap potential drop on interplanetary parameters. *J. Geophys. Res.—Space Phys.* 86:7639-48, 1981. Rice Univ., Space Phys. Astron. Dept., Houston, TX. 83-0390
2	12	12	26	**Rice A.** Convective fractionation: a mechanism to provide cryptic zoning (macrosegregation), layering, crescumulates, banded tuffs and explosive volcanism in igneous processes. *J. Geophys. Res.* 86:405-17, 1981. Univ. Newcastle upon Tyne, Sch. Phys., Newcastle upon Tyne, UK.
1	12	15	28	**Rice D D & Claypool G E.** Generation, accumulation, and resource potential of biogenic gas. *AAPG Bull.—Amer. Ass. Petrol. G.* 65:5-25, 1981. US Geol. Survey, Denver, CO. 83-1537
0	9	17	26	**Richter F M & McKenzie D P.** On some consequences and possible causes of layered mantle convection. *J. Geophys. Res.* 86:6133-42, 1981. Univ. Chicago, Dept. Geophys. Sci., Chicago, IL; Cambridge Univ., Dept. Earth Sci., Cambridge, UK.
1	11	21	33	**Rothman L S.** AFGL atmospheric absorption line parameters compilation: 1980 version. *Appl. Opt.* 20:791-5, 1981. US Air Force (USAF), Opt. Phys. Div., Hanscom AFB, MA. 83-4567
3	12	13	28	**Ruddiman W F & McIntyre A.** Oceanic mechanisms for amplification of the 23,000-year ice-volume cycle. *Science* 212:617-27, 1981. Columbia Univ., Lamont-Doherty Geol. Observ., Palisades; CUNY, Queens Coll., New York, NY.
3	13	15	31	**Samuelson R E, Hanel R A, Kunde V G & Maguire W C.** Mean molecular weight and hydrogen abundance of Titan's atmosphere. *Nature* 292:688-93, 1981. NASA/Goddard Space Flight Ctr., Greenbelt, MD.
4	12	19	35	**Schuetzle D, Lee F S-C, Prater T J & Tejada S B.** The identification of polynuclear aromatic hydrocarbon (PAH) derivatives in mutagenic fractions of diesel particulate extracts. *Int. J. Environ. Anal. Chem.* 9:93-144, 1981. Ford Motor Co., Anal. Sci. Dept., Dearborn, MI; US Environ. Protect. Agcy., Environ. Sci. Res. Lab., Research Triangle Park, NC. 82-2806
11	10	11	32	**Scudder J D, Sittler E C & Bridge H S.** A survey of the plasma electron environment of Jupiter: a view from Voyager. *J. Geophys. Res.—Space Phys.* 86:8157-79, 1981. NASA/Goddard Space Flight Ctr., Lab. Extraterr. Phys., Greenbelt, MD; Mass. Inst. Technol., Ctr. Space Res., Cambridge, MA.
2	10	13	25	**Sharp R D, Carr D L, Peterson W K & Shelley E G.** Ion streams in the magnetotail. *J. Geophys. Res.—Space Phys.* 86:4639-48, 1981. Lockheed Palo Alto Res. Lab., Palo Alto, CA.
22	62	52	136	**Smith B A, Soderblom L, Beebe R, Boyce J, Briggs G, Bunker A, Collins S A, Hansen C J, Johnson T V, Mitchell J L, Terrile R J, Carr M, Cook A F, Cuzzi J, Pollack J B, Danielson G E, Ingersoll A, Davies M E, Hunt G E, Masursky H, Shoemaker E, Morrison D, Owen T, Sagan C, Veverka J, Strom R & Suomi V E.** Encounter with Saturn: Voyager 1 imaging science results. *Science* 212:163-91, 1981. Univ. Arizona, Dept. Planet. Sci. & Lunar Planet. Lab., Tucson; US Geol. Survey, Flagstaff, AZ; New Mexico State Univ., Dept. Astron., Las Cruces, NM; NASA Headquarters, Washington, DC; Calif. Inst. Technol., Jet Propulsion Lab. & Div. Geol. Planet. Sci., Pasadena; US Geol. Survey, Menlo Park; NASA/Ames Res. Ctr., Moffett Field; Rand Corp., Santa Monica, CA; Ctr. Astrophys., Cambridge, MA; Univ. Coll. London, London, UK; Univ. Hawaii, Inst. Astron., Honolulu, HI; SUNY, Dept. Earth Space Sci., Stony Brook; Cornell Univ., Ithaca, NY; Univ. Wisconsin, Madison, WI. 83-3458; 82-1234
0	15	11	26	**Sorensen J, Christensen D & Jorgensen B B.** Volatile fatty acids and hydrogen as substrates for sulfate-reducing bacteria in anaerobic marine sediment. *Appl. Environ. Microbiol.* 42:5-11, 1981. Univ. Aarhus, Inst. Ecol. Genet., Aarhus, Denmark. 82-0159
1	10	18	29	**Styrt M M, Brackmann A J, Holland H D, Clark B C, Pisutha-Arnond V, Eldridge C S & Ohmoto H.** The mineralogy and the isotopic composition of sulfur in hydrothermal sulfide/sulfate deposits on the East Pacific Rise, 21 N latitude. *Earth Planet. Sci. Lett.* 53:382-90, 1981. Mass. Inst. Technol., Dept. Earth Planet. Sci.; Harvard Univ., Dept. Geol. Sci., Cambridge, MA; Martin Marietta Aerospace, Denver, CO; Penn. State Univ., Dept. Geosci., University Park, PA.
2	12	20	34	**Suresh S, Zamiski G F & Ritchie R O.** Oxide-induced crack closure: an explanation for near-threshold corrosion fatigue crack growth behavior. *Met. Trans. A—Phys. Met. Mater. Sc.* 12:1435-43, 1981. Mass. Inst. Technol., Dept. Mech. Eng., Cambridge, MA; McDonnell-Douglas Corp., Redondo Beach; Univ. California, Dept. Mater. Sci. Mineral Eng. & Lawrence Berkeley Lab., Berkeley, CA. 83-1808

A	B	C	D	E
1	9	19	29	**Taylor S R & McLennan S M.** The composition and evolution of the continental crust: rare earth element evidence from sedimentary rocks. *Phil. Trans. Roy. Soc. London A* 301:381-99, 1981. Australian Natl. Univ., Res. Sch. Earth Sci., Canberra, Australia.
5	14	12	31	**Tipping E.** The adsorption of aquatic humic substances by iron oxides. *Geochim. Cosmochim. Acta* 45:191-9, 1981. Freshwater Biol. Assn., Ambleside, UK.
8	10	9	27	**Tsunoda R T.** Time evolution and dynamics of equatorial backscatter plumes. 1. Growth phase. *J. Geophys. Res.—Space Phys.* 86:139-49, 1981. SRI Intl., Menlo Park, CA.
11	32	36	79	**Tyler G L, Eshleman V R, Anderson J D, Levy G S, Lindal G F, Wood G E & Croft T A.** Radio science investigations of the Saturn system with Voyager 1: preliminary results. *Science* 212:201-6, 1981. Stanford Univ., Ctr. Radar Astron., Stanford; Calif. Inst. Technol., Jet Propulsion Lab., Pasadena; SRI Intl., Radio Phys. Lab., Menlo Park, CA. 83-3458; 82-1234
14	32	1	47	**Vaiana G S, Cassinelli J P, Fabbiano G, Giacconi R, Golub L, Gorenstein P, Haisch B M, Harnden F R, Johnson H M, Linsky J L, Maxson C W, Mewe R, Rosner R, Seward F, Topka K & Zwaan C.** Results from an extensive *Einstein* stellar survey. *Astrophys. J.* 245:163-82, 1981. Harvard-Smithsonian Ctr. Astrophys., Cambridge, MA. 81-1691; 83-0564
3	11	14	28	**van Loon H & Madden R A.** The Southern Oscillation. Part I: global associations with pressure and temperature in northern winter. *Mon. Weather Rev.* 109:1150-62, 1981. Natl. Ctr. Atmos. Res., Boulder, CO.
5	13	13	31	**Vickrey J F, Vondrak R R & Matthews S J.** The diurnal and latitudinal variation of auroral zone ionospheric conductivity. *J. Geophys. Res.—Space Phys.* 86:65-75, 1981. SRI Intl., Radio Phys. Lab., Menlo Park, CA.
5	17	24	46	**Wallace J M & Gutzler D S.** Teleconnections in the geopotential height field during the Northern Hemisphere winter. *Mon. Weather Rev.* 109:784-812, 1981. Univ. Washington, Dept. Atmos. Sci., Seattle, WA. 83-0958
4	18	9	31	**Wallis D D & Budzinski E E.** Empirical models of height integrated conductivities. *J. Geophys. Res.—Space Phys.* 86:125-37, 1981. Natl. Res. Council Canada, Herzberg Inst. Astrophys., Ottawa, Canada. 82-0331
13	16	18	47	**Warwick J W, Pearce J B, Evans D R, Carr T D, Schauble J J, Alexander J K, Kaiser M L, Desch M D, Pedersen M, Lecacheux A, Daigne G, Boischot A & Barrow C H.** Planetary radio astronomy observations from Voyager 1 near Saturn. *Science* 212:239-43, 1981. Radiophys., Inc., Boulder, CO; Univ. Florida, Dept. Astron., Gainesville, FL; NASA/Goddard Space Flight Ctr., Lab. Extraterr. Phys., Greenbelt, MD; Sect. Astrophys. Meudon, Paris Observ., Meudon, France. 83-3458; 82-1234
2	19	20	41	**Webster P J.** Mechanisms determining the atmospheric response to sea surface temperature anomalies. *J. Atmos. Sci.* 38:554-71, 1981. CSIRO, Div. Atmos. Phys., Victoria, Australia. 82-1054
0	10	19	29	**Williamson P G.** Palaeontological documentation of speciation in Cenozoic molluscs from Turkana Basin. *Nature* 293:437-43, 1981. Harvard Univ., Museum Compar. Zool., Cambridge, MA. 83-5706
4	20	15	39	**Willson R C, Gulkis S, Janssen M, Hudson H S & Chapman G A.** Observations of solar irradiance variability. *Science* 211:700-2, 1981. Calif. Inst. Technol., Jet Propulsion Lab., Pasadena; Univ. California, San Diego, Ctr. Astrophys. Space Sci., La Jolla; California State Univ., San Fernando Observ., Northridge, CA.
0	15	13	28	**Woodruff F, Savin S M & Douglas R G.** Miocene stable isotope record: a detailed deep Pacific ocean study and its paleoclimatic implications. *Science* 212:665-8, 1981. Univ. S. California, Dept. Geol. Sci., Los Angeles, CA; Case Western Reserve Univ., Dept. Geol. Sci., Cleveland, OH.
0	10	17	27	**Young D T, Perraut S, Roux A, de Villedary C, Gendrin R, Korth A, Kremser G & Jones D.** Wave-particle interactions near ΩHe^{+} observed on GEOS 1 and 2. 1. Propagation of ion cyclotron waves in He^{+}-rich plasma. *J. Geophys. Res.—Space Phys.* 86:6755-72, 1981. Univ. Bern, Phys. Inst., Bern, Switzerland; Ctr. Res. Phys. Environ., Terr. Planet & Ctr. Natl. Stud. Telecommun., Issy-les-Moulineaux, France; Max Planck Inst. Aeronom., Katlenburg-Lindau, FRG; ESTEC, Space Sci. Dept., Noordwijk, Holland.
8	17	1	26	**Zamorani G, Henry J P, Maccacaro T, Tananbaum H, Soltan A, Avni Y, Liebert J, Stocke J, Strittmatter P A, Weymann R J, Smith M G & Condon J J.** X-ray studies of quasars with the *Einstein* observatory. II. *Astrophys. J.* 245:357-74, 1981. Harvard-Smithsonian Ctr. Astrophys., Cambridge, MA; Copernicus Astron. Ctr., Warsaw, Poland; Weizmann Inst. Sci., Rehovot, Israel; Univ. Arizona, Steward Observ., Tucson, AZ; Royal Observ., Edinburgh, UK; Natl. Radio Astron. Observ. & Virginia Polytech. Inst. State Univ., Dept. Phys., Blacksburg, VA. 83-0564; 82-1178

Table 2: 1981, 1982, and 1983 ISI® research fronts for which the papers in this study are core documents. A = research front number. B = research front name. C = number of geosciences papers in the core of each research front. D = total number of core papers in each research front.

A	B	C	D
81-1691	X-ray astrophysics	1	2
82-0159	Kinetics of bacterial methanogenesis and sulfate reduction in estuarine and marine sediments	1	19
82-0331	Relationships between field-aligned currents and auroral phenomena	2	20
82-0401	Isotope geochemistry of oceanic basalts and mantle evolution; isotope geochemistry of oceanic basalts, island arc magmas and continental rocks	1	22
82-0411	Photoemission studies of surface core-level binding energy shifts in rare-earth metal compounds	1	3
82-0412	Photoemission studies of mixed valence and 4F-surface chemical shifts in cerium compounds	1	4
82-1054	Tropical sea-surface temperature-field and surface wind-field variability associated with Southern Oscillation El-Nino	3	7
82-1086	Magnetosphere-ionosphere coupling and auroral plasma	1	15
82-1169	Geochemical studies of volcanic rocks and the mantle	1	3
82-1178	X-ray emission from quasars, Seyfert galaxies and active galactic nuclei	1	12
82-1234	Voyager 1 and Voyager 2 observations of Saturn and Titan and analysis of rings of Saturn, magnetosphere and atmosphere	8	9
82-1921	Seismic wave investigations of mantle and core structure	1	2
82-2384	Effects of increased carbon dioxide in the atmosphere on the climate	1	5
82-2806	Isolation, identification and mutagenic properties of nitrated polycyclic aromatic hydrocarbons	1	4
83-0390	Auroral processes and the magnetosphere and ionosphere	5	33
83-0408	Crustal and mantle velocity structures using earthquake data and inversion techniques	1	14
83-0564	X-ray, radio and optical observations of Seyfert galaxies, stars, quasi-stellar objects and other objects	2	56
83-0687	Cretaceous and early tertiary magnetic stratigraphy and biostratigraphy	1	7
83-0867	Deep-sea drilling project results: hydrothermal mounds of the Galapagos Rift and other spreading centers	1	12
83-0924	Models and observations of baroclinic instability and other middle atmosphere flows	1	34
83-0958	Equatorial Pacific sea-surface temperatures and climate: the El-Nino Southern Oscillation	4	15
83-1145	Paleomagnetic and tectonic studies: determining the structure and evolution of the crust and upper mantle	1	51
83-1213	Origin and geochemistry of granites and other igneous rocks	1	14
83-1353	Adsorption properties and other surface properties of ruthenium dioxide and related oxide catalysts in aqueous solution	1	36
83-1537	Hydrocarbon generation and subsidence, thermal evolution and organic geochemistry of sedimentary basins	2	27
83-1538	Observation and properties of the Io plasma torus and its interaction with the Jovian magnetosphere	1	2
83-1708	Diffusion induced grain-boundary migration and related processes in copper alloys	1	5
83-1808	Fatigue crack growth and fracture toughness in steels and other materials	1	33
83-3458	Voyager observations of Saturn's ring magnetosphere and ice-rich satellites with emphasis on Titan and its atmosphere	6	23
83-4040	Evidence for mantle and crust evolution from mineralogy and trace element chemistry of the Columbia River basalts	1	2
83-4567	Measurements of atmospheric constituents by infrared spectroscopy	2	8
83-4677	Structure and properties of graphite intercalation compounds including those containing potassium and other alkali metals	1	14
83-5706	Systematics, biogeography, cladistic analysis and aspects of phylogenetic relationships in patterns of speciation and evolution	1	20
83-5753	Relationship of atmospheric carbon dioxide and changes in climate and global sea level	2	11
83-8298	Sources and distributions of atmospheric ozone, methane and carbon monoxide	2	3

Table 3: The number of authors on the geosciences papers. A = number of authors. B = number of papers having that number of authors.

A	B
27	1
16	3
15	1
13	1
12	1
10	2
8	3
7	5
6	2
5	5
4	8
3	20
2	30
1	17

Table 4: The 30 journals represented on the list of the 99 geosciences papers most cited 1981-1983. The numbers in parentheses are the impact factors for the journals. (1983 impact factor equals the number of 1983 citations received by 1981-1982 articles, divided by the number of articles published by the journal during the same period.) The figures at the right indicate the number of papers from each journal which appear on the list.

Journal	No. of Papers
*J. Geophys. Res. (3.71)	32
Science (7.41)	19
J. Atmos. Sci. (3.17)	5
Earth Planet. Sci. Lett. (3.34)	4
Mon. Weather Rev. (2.62)	4
Nature (9.26)	4
Astrophys. J. (3.94)	3
Geophys. Res. Lett. (2.93)	3
Deep-Sea Res. Pt. A—Oceanog. Res. (NA)	2
Geochim. Cosmochim. Acta (3.54)	2
Phys. Earth Planet. Interiors (1.75)	2
AAPG Bull.—Amer. Ass. Petrol. G. (1.36)	1
Acta Met. (2.07)	1
Advan. Phys. (12.76)	1
Appl. Environ. Microbiol. (2.08)	1
Appl. Opt. (1.81)	1
Atmos. Environ. (1.97)	1
Eos (NA)	1
Geol. Soc. Amer. Bull. (1.76)	1
Geology (2.37)	1
Int. J. Environ. Anal. Chem. (1.36)	1
J. Colloid Interface Sci. (1.48)	1
J. Geol. Soc. (1.88)	1
J. Phys. F—Metal Phys. (2.24)	1
Met. Trans. A—Phys. Met. Mater. Sc. (1.39)	1
Phil. Trans. Roy. Soc. London A (1.58)	1
Planet. Space Sci. (2.14)	1
Rep. Progr. Phys. (7.18)	1
Rev. Geophys. Space Phys. (4.46)	1
Space Sci. Rev. (1.74)	1

*Includes J. Geophys. Res., J. Geophys. Res—Space Phys., and J. Geophys. Res.—Ocean. Atmos.

small number of journals accounts for the majority of high-impact papers and citations.

Ninety-one institutions were listed on the articles. In Table 5, they are shown in descending order by the number of times they appear in Table 1. Authors based at US institutions appeared on 85 papers. The UK was represented on nine papers, France on seven, and the Federal Republic of Germany (FRG) on six. Australia, Canada, and Switzerland account for three papers each. Denmark, Holland, Israel, Japan, and Poland contributed one paper each.

Of course, many of these papers were multinational collaborations. For example, of the 85 US papers, 15 listed coauthors from Australia, Canada, France, FRG, Israel, Japan, Poland, Switzerland, and the UK. Seventy papers listed *only* US authors. Table 6 shows the total number of papers from each of the 12 nations represented in this study. Also shown are the number that were multinationally coauthored, and the national affiliations of the collaborators. Although these high-impact geosciences papers were from a dozen nations, every one was published in English.

Seven authors in Table 1 were among the 1,000 contemporary scientists most cited from 1965 through 1978.[5] They are: S.-I. Akasofu, E.E. Ferguson, R. Giacconi, X. Le Pichon, M.B. McElroy, N.F. Ness, and R.J. Phillips. Interestingly, Le Pichon was the only geophysicist listed in that study. The specialties of the others include aeronomy, astronomy, inorganic chemistry, and physics.

More than 25 astrosciences papers are in Table 1. Most of these deal with planetary science research, the study of the components of our solar system other than the sun, including the solid, liquid, and gaseous parts of other planets. Indeed, 17 papers report results

Table 5: The institutional affiliations of the authors on the list. Institutions are listed in descending order of the number of times they appear in Table 1.

Institution		Frequency
Univ. California, CA		16
Los Angeles	7	
San Diego[1]	3	
Berkeley	2	
Santa Barbara	2	
Irvine	1	
Los Alamos, NM	1	
NASA		13
Goddard Space Flight Ctr., Greenbelt, MD	11	
Ames Res. Ctr., Moffett Field, CA	1	
Headquarters, Washington, DC	1	
California Inst. Technol., Pasadena, CA		10
Harvard Univ., Cambridge, MA[2]		10
Massachusetts Inst. Technol., Cambridge, MA		7
US Geol. Survey		7
Menlo Park, CA	5	
Denver, CO	1	
Flagstaff, AZ	1	
Natl. Ctr. Atmos. Res. (NCAR), Boulder, CO		6
Max Planck Soc., FRG		5
Inst. Aeronom., Katlenburg-Lindau	4	
Inst. Nucl. Phys., Heidelberg	1	
Natl. Ocean Atmos. Admin. (NOAA)		5
Boulder, CO	3	
Silver Spring, MD	1	
Washington, DC	1	
Univ. Washington, Seattle, WA		5
Rice Univ., Houston, TX		4
Univ. Arizona, Tucson, AZ		4
Univ. S. California, CA		4
Los Angeles	2	
Tucson, AZ	2	
Columbia Univ., NY		3
Palisades	2	
New York City	1	
Cornell Univ., Ithaca, NY		3
Johns Hopkins Univ., MD		3
Laurel	2	
Baltimore	1	
SRI Intl., Menlo Park, CA		3
Stanford Univ., CA		3
Univ. Iowa, Iowa City, IA		3
Univ. Maryland, College Park, MD		3
USAF, Hanscom AFB, Bedford, MA		3
USN, Naval Res. Lab., Washington, DC		3
Bell Labs., Murray Hill, NJ		2
CNRS, Serv. Aeronom., Verrieres-le-Buisson, France		2
CSIRO, Div. Atmos. Phys., Victoria, Australia		2
Oregon Grad. Ctr., Beaverton, OR		2
Paris Observ., Meudon, France		2
Regis Coll., Weston, MA		2
Swiss Fed. Inst. Technol., Zurich, Switzerland		2
Geophys. Inst. & Swiss Earthquake Serv.	1	
Solid State Phys. Lab.	1	
TRW Defense Space Syst. Group, Redondo Beach, CA		2
Univ. Hawaii, Honolulu, HI		2
Univ. Kansas, Lawrence, KA		2
Univ. Michigan, Ann Arbor, MI		2
Woods Hole Oceanogr. Inst., MA		2
Aerospace Corp., Los Angeles, CA		1
Arizona State Univ., Tempe, AZ		1
Atmos. Environ. Serv., Toronto, Canada		1
Australian Natl. Univ., Canberra, Australia		1
California State Univ., Northridge, CA		1
Cambridge Univ., UK		1
Case Western Reserve Univ., Cleveland, OH		1
Copernicus Astronom. Ctr., Warsaw, Poland		1
CUNY, New York, NY		1
Earth Planet. Environ. Phys. Res. Ctr., Issy-les-Moulineaux, France		1
ESTEC, Noordwijk, Holland		1
Ford Motor Co., Dearborn, MI		1
Goddard Inst. Space Stud., New York, NY		1
Kyoto Sangyo Univ., Kyoto, Japan		1
Lockheed Palo Alto Res. Lab., CA		1
Lunar Planet. Inst., Houston, TX		1
Martin Marietta Aerospace, Denver, CO		1
McDonnell-Douglas Corp., Redondo Beach, CA		1
Meteorol. Off., Bracknell, UK		1
Natl. Bur. Stand., Washington, DC		1
Natl. Ctr. Telecommun. Stud., Issy-les-Moulineaux, France		1
Natl. Environ. Res. Council (NERC), Freshwater Biol. Assn., Ambleside, UK		1
Natl. Radio Astron. Observ., Green Bank, WV		1
Natl. Res. Council Canada, Ottawa, Canada		1
New Mexico State Univ., Las Cruces, NM		1
ORSTOM, Ctr. Oceanol., Brest, France		1
Oxford Univ., UK		1
Pennsylvania State Univ., University Park, PA		1
Polytech. Inst. New York, NY		1
Radiophys., Inc., Boulder, CO		1
Rand Corp., Santa Monica, CA		1
Royal Observ., Edinburgh, UK		1
Skidaway Inst. Oceanogr., Savannah, GA		1
Smithsonian Inst., Washington, DC		1
SUNY, Stony Brook, NY		1
Tech. Univ., Braunschweig, FRG		1
Texas A&M Univ., College Station, TX		1
Univ. Aarhus, Denmark		1
Univ. Alaska, Fairbanks, AK		1
Univ. Bern, Switzerland		1
Univ. Chicago, IL		1
Univ. Denver, CO		1
Univ. Florida, Gainesville, FL		1
Univ. London, UK		1
Univ. Massachusetts, Amherst, MA		1
Univ. Miami, FL		1
Univ. Minnesota, Minneapolis, MN		1
Univ. Nantes, France •		1
Univ. Newcastle upon Tyne, UK		1
Univ. Paris VI, France		1
Univ. Reading, UK		1
Univ. Wales, Aberystwyth, UK		1
Univ. Wisconsin, Madison, WI		1
US Environ. Protection Agcy., Research Triangle Park, NC		1
Virginia Polytech. Inst. State Univ., Blacksburg, VA		1
Weizmann Inst. Sci., Rehovot, Israel		1
York Univ., Toronto, Canada		1

[1]Includes Ctr. Astrophys. Space Sci. & Scripps Inst. Oceanogr., La Jolla, CA
[2]Includes Harvard-Smithsonian Ctr. Astrophys.

based on observations made by the US unmanned spacecraft *Voyager 1*, which flew past Jupiter in March 1979, and past Saturn in November 1980. Nine of these papers were published consecutively in the April 1981 issue of *Science*—includ-

Table 6: National affiliations of the authors of the 1981 geosciences papers most cited in 1981-1983, in order of the total number of papers on which each nation's authors appeared (column A). B = number of papers coauthored with scientists from other countries. C = nationalities of coauthors.

Country	A	B	C
US	85	15	Australia, Canada, France, FRG, Israel, Japan, Poland, Switzerland, UK
UK	9	4	Israel, Poland, Switzerland, US
France	7	6	Canada, FRG, Holland, Switzerland, US
FRG	6	5	France, Holland, Switzerland, US
Australia	3	1	US
Canada	3	1	France, US
Switzerland	3	3	France, FRG, Holland, UK, US
Denmark	1	0	
Holland	1	1	France, FRG, Switzerland
Israel	1	1	Poland, UK, US
Japan	1	1	US
Poland	1	1	Israel, UK, US

ing three of the five most-cited papers in this study. Roughly 25 other papers fall under the category of atmospheric science. Other specialties represented include oceanography, meteorology, geochemistry, and geophysics.

Five papers were cited at least 79 times each. The three papers based on *Voyager 1* data discuss various observations of Saturn and its satellite system. B.A. Smith and a team of 26 other researchers reported on the imaging science results of the *Voyager 1* mission. This paper received 136 citations—22 in 1981, 62 in 1982, and 52 in 1983. R. Hanel and colleagues discussed the orbits of Saturn's small satellites, some of which were first discovered by *Voyager 1*. Cited 87 times, the paper picked up 13 citations in 1981, 40 in 1982, and 34 in 1983. G.L. Tyler and colleagues presented the results of radio science investigations of the Saturn system. The paper received 79 citations—11 in 1981, 32 in 1982, and 36 in 1983.

The other two papers among the top five discuss the atmosphere and internal structure of the Earth itself. J.D. Horel and J.M. Wallace, University of Washington, Seattle, analyzed "Planetary-scale atmospheric phenomena associated with the Southern Oscillation." They discussed some of the effects associated with a global pattern of yearly fluctuations in sea-level air pressure, temperature, and precipitation. The paper was cited 86 times—eight times in 1981, 32 in 1982, and 46 in 1983.

A.M. Dziewonski, Harvard University, Cambridge, Massachusetts, and D.L. Anderson, California Institute of Technology, Pasadena, coauthored the paper entitled "Preliminary reference Earth model." It sets up a computer model of the Earth's internal structure which has numerous applications, including research on tides and the Earth's rotation. The paper was cited 79 times, twice in 1981, 30 times in 1982, and 47 in 1983.

It is interesting to note that at least two of the 99 geosciences papers are in fact directly related to the life sciences. One, by C.M. Cavanaugh, Museum of Comparative Zoology, Harvard University, and colleagues, suggests the existence of, and the symbiotic relationship between, tube worms and a type of sulfur-oxidizing bacteria. Both species thrive at the bottom of the ocean among the lava vents lining tectonic ridges. The other, by J. Sørensen, D. Christensen, and B.B. Jørgensen, all of the Institute of Ecology and Genetics, University of Aarhus, Denmark, describes some of the environmental requirements of coastal marine bacteria that metabolize sulfates. Both papers were cited 26 times each—the former receiving seven citations in 1981, ten in 1982, and nine in 1983, while the latter, published in July 1981, was not cited at all that year, but received 15 cites in 1982 and 11 in 1983. Their relatively quick impact indicates their importance for oceanographers and others who study the ever-changing dynamics of the sea.

This concludes our discussion of the 1981 earth sciences papers. Since a paper's lifetime citation expectancy can be forecasted reasonably well by its citation frequency within the first few years following its publication, it is safe to assume that most of the papers in this study will continue to be well cited in the future. Helmut A. Abt, Kitt Peak National Observatory, Tucson, Arizona, analyzed the citation histories of more than 300 astronomical papers.[6] He found that the highly cited papers did not peak in citations until seven years after publication. In contrast, less frequently cited papers reached their peak after four years. In addition, the high-impact papers had a longer citation history, reaching their "half-life" after 27 years. The half-life for the less frequently cited papers was just 16 years.

The composition of this list is, of course, determined by the data base used to identify the most-cited geosciences papers. Even within the relatively "narrow" scope of the earth sciences, there are small fields that produce important work. By examining the individual geoscience research fronts we identify each year, we can pinpoint creative work on specific topics. It will be interesting to see how each of these research fronts develops over the next several years.

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