

2020 Scientific Ocean Drilling Bibliographic Database and Publication Impact Report

Covering records related to the Deep Sea Drilling Project,
Ocean Drilling Program, Integrated Ocean Drilling Program,
and International Ocean Discovery Program
from 1969 through June 2020

Produced by
International Ocean Discovery Program
Publication Services

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Introduction

This Scientific Ocean Drilling Bibliographic Database and Publication Impact Report demonstrates the impact of Program science through publications from the Deep Sea Drilling Project (DSDP), Ocean Drilling Program (ODP), Integrated Ocean Drilling Program, and International Ocean Discovery Program (IODP). The first section presents statistics from the bibliographic records indexed by the American Geosciences Institute (AGI) in the Scientific Ocean Drilling Bibliographic Database (previously named the Ocean Drilling Citation Database) as of June 2020. The second section covers alternative impact metrics. Citation statistics obtained from Google Scholar in July 2020 and links to Altmetric scores for high-impact papers demonstrate trends in societal relevance and research usage.

Report categories

Data collected for the annual Scientific Ocean Drilling Bibliographic Database Report are divided into two main categories:

- Program records: publications produced and published by the ocean drilling Programs DSDP, ODP, the Integrated Ocean Drilling Program, and IODP. These records include but are not limited to
 - The *Initial Reports of the Deep Sea Drilling Project*,
 - The *Initial Reports* and *Scientific Results Proceedings* volumes of ODP;
 - The *Proceedings* volumes of the Integrated Ocean Drilling Program (IODP-1) and IODP (IODP-2),
 - The technical note series from ODP and IODP, and
 - The journal *Scientific Drilling* from 2006 to 2013.
- Non-Program records: Program-related scientific research published in the open literature. Non-Program publications are further categorized into three groups:
 - Serial records: drawn from any periodically produced analytic or monographic journal or report, especially those that are peer reviewed, but may also include reports from universities, organizations, or government entities (e.g., *Open-File Reports—U.S. Geological Survey*).
 - Theses and dissertations: Bachelor's and Master's theses and Ph.D. dissertations.
 - Miscellaneous records: books, reports, monographs, maps, abstracts, posters, newsletters, videos, and CD-ROM/DVD-ROMs.

Scientific Ocean Drilling Bibliographic Database

The Scientific Ocean Drilling Bibliographic Database is a subset of AGI's GeoRef database. To generate the GeoRef database, AGI indexes and records bibliographic data from approximately 3,300 domestic and international publications. AGI also has arrangements to acquire metadata with many publishers including Springer, Elsevier, the American Association for the Advancement of Science, Copernicus, Wiley/Blackwell, the American Geophysical Union, and most of the Geoscience World publishers. In addition, IODP Publication Services notifies AGI when Program publications are released.

AGI produces the Scientific Ocean Drilling Bibliographic Database in collaboration with IODP. AGI uses a series of keywords to extract bibliographic records related to Program research from the GeoRef database. The database resides on the AGI server (<http://iodp.americangeosciences.org/vufind>) and is updated weekly. Metadata associated with each record can be saved to a personalized list, texted or emailed, or exported into common bibliographic software. The database also generates references in several formats.

Depending on the source from which AGI acquires its information, there may be a significant delay after publication before a record is included in the GeoRef database and later in the Scientific Ocean Drilling Bibliographic Database. There is no guarantee that all publication venues for Program research are included in GeoRef or the Scientific Ocean Drilling Bibliographic Database, but scientific publications throughout the world are represented.

As of June 2020, the database contains 37,770 records, each including metadata, from publications published from 1969 to 2020 (beginning of DSDP to present), including ~74% non-Program records and ~26% Program records (Figure 1). Since the 2019 report, 1,361 records have been added to the database. Figure 1 highlights the ~2% theses and dissertations (total = ~758) in the database that illustrate early career scientific research relating to the Program and details serial publications related to IODP and its predecessor programs. Figure 2 shows these records based on all authors' country of affiliation. All maps in this report were generated using the Science of Science (Sci2) Tool (<http://sci2.cns.iu.edu>).

Figure 1. Overview of records in the Scientific Ocean Drilling Bibliographic Database as of June 2020 (total = 37,770).

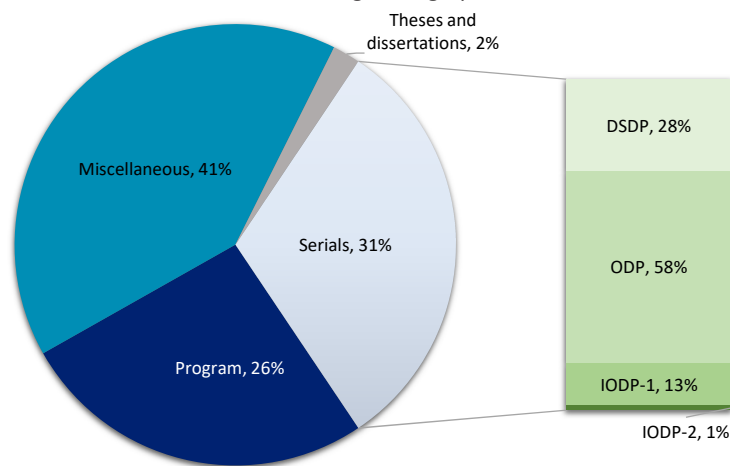
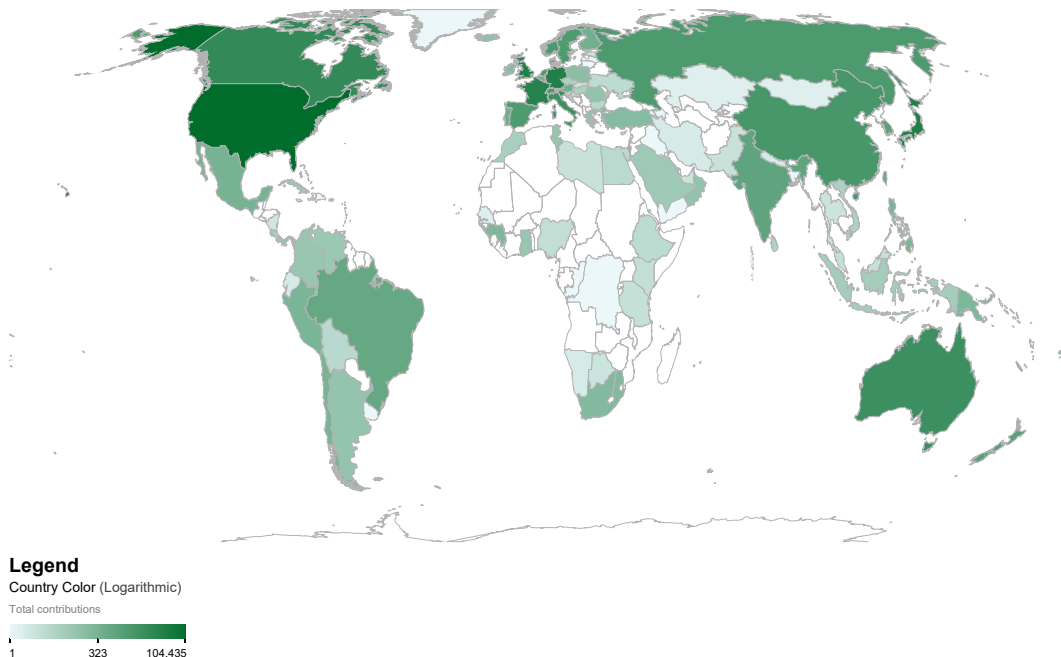


Figure 2. All records in the Scientific Ocean Drilling Bibliographic Database as of June 2020 by affiliation country of all authors.



All Programs (1969–2020)

Publications from top-ranking peer-reviewed journals

Database records indicate that 11,798 Program-related papers have been published in non-Program, primarily peer-reviewed serial publications. A total of 6,391 of these research papers (~54% of the serial publications in the database) were published in 30 highly ranked peer-reviewed journals, based on the Clarivate Analytics 2019 journal impact factor (Figure 3). Starting in 1996, ODP encouraged scientists to publish postcruise research results in English language peer-reviewed journals rather than the Program *Proceedings* volumes. Figure 3 includes the highly ranked journals that have published a total 50 or more research papers related to DSDP and ODP (1969–2002) and IODP-1 and IODP-2 (2003–present). Journal impact factors are shown in parentheses. Table 1 presents the data behind this graph.

Figure 3. Highly ranked peer-reviewed serials publishing Program-related expedition research results (1969–2020).

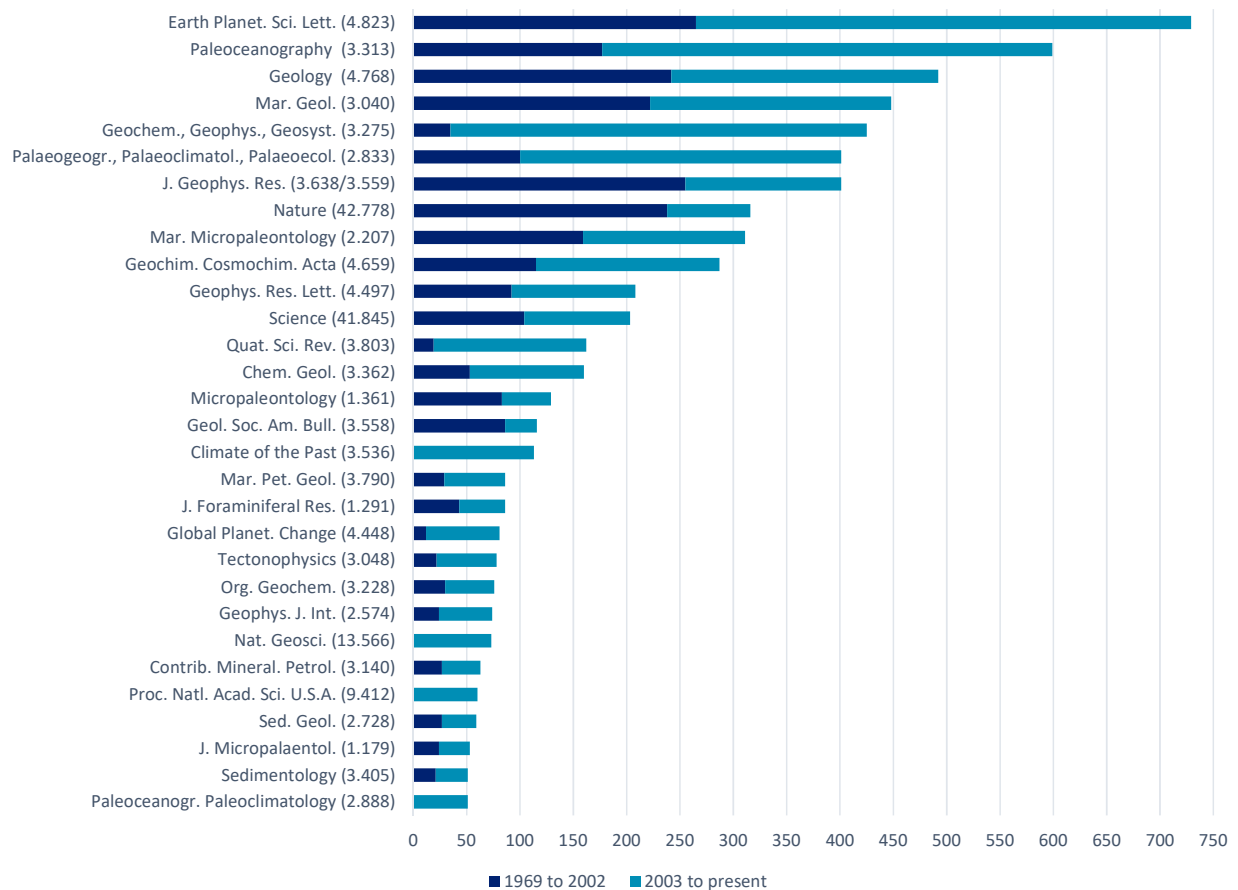


Table 1. Highly ranked peer-reviewed serials publishing Program-related expedition research results (1969–2020).

Journal	Journal Impact Factor (2019)	Number of Program-related papers published		
		1969–2002	2003–2020	Total
Nature	42.778	238	78	316
Science	41.845	104	99	203
Nature Geoscience	13.566	0	73	73
Proceedings of the National Academy of Sciences of the U.S.A.	9.412	0	60	60
Earth and Planetary Science Letters	4.823	265	464	729
Geology	4.768	242	250	492
Geochimica et Cosmochimica Acta	4.659	115	172	287
Geophysical Research Letters	4.497	92	116	208
Global and Planetary Change	4.448	12	69	81
Quaternary Science Reviews	3.803	19	143	162
Marine and Petroleum Geology	3.790	29	57	86
Journal of Geophysical Research (Solid Earth, Oceans)	3.638/3.559	255	146	401
Geological Society of America Bulletin	3.558	86	30	116
Climate of the Past	3.536	0	113	113
Sedimentology	3.405	21	30	51
Chemical Geology	3.362	53	107	160
Paleoceanography	3.313	177	422	599
Geochemistry, Geophysics, Geosystems	3.275	35	390	425
Organic Geochemistry	3.228	30	46	76
Contributions to Mineralogy and Petrology	3.140	27	36	63
Tectonophysics	3.048	22	56	78
Marine Geology	3.040	222	226	448
Paleoceanography and Paleoclimatology	2.888	0	51	51
Palaeogeography, Palaeoclimatology, Palaeoecology	2.833	100	301	401
Sedimentary Geology	2.728	27	32	59
Geophysical Journal International	2.574	24	50	74
Marine Micropaleontology	2.207	159	152	311
Micropaleontology	1.361	83	46	129
Journal of Foraminiferal Research	1.291	43	43	86
Journal of Micropalaeontology	1.179	24	29	53

Publications by authors from current member countries

Of the 11,798 Program-related papers published in serial publications, 10,342 (~88%) are first-authored by scientists from current IODP funding entities, which include the following.

- National Science Foundation (NSF), United States;
- Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan;
- European Consortium for Ocean Research Drilling (ECORD);
- Ministry of Science and Technology (MOST), People’s Republic of China;
- Korea Institute of Geoscience and Mineral Resources (KIGAM);
- Australia-New Zealand IODP Consortium (ANZIC);
- Ministry of Earth Sciences (MoES), India; and
- Coordination for Improvement of Higher Education Personnel (CAPES), Brazil.

Table 2 shows publication statistics for member countries and consortia, including the following.

- First author: the correspondence author of a paper.
- Contributing authors: co-authors listed on a paper.
- Serial contributions by country: the number of papers that list contributing authors from each country. The country is counted once per paper regardless of the number of authors from that country.
- Serial contributions by author: the number of contributing authors from each country. Multiple contributors from a single country are each counted.
- Total contributions: the total number of times researchers from each country are included in the authorship of peer-reviewed serials, including first and contributing authors and multiple contributors from a single country per paper.

Table 2. Serial publication for peer-reviewed serials showing counts by first author, contributing country, contributing authors, and total contributions by all authors from current IODP member countries (1969–2020).

IODP member country or consortia	First authors of serials	Serial contributions by country	Serial contributions by author	Total contributions by all authors
Australia/New Zealand Consortium	348	536	674	1,022
Australia	199	354	423	622
New Zealand	149	182	251	400
Brazil	27	46	48	75
China	481	389	529	1,010
ECORD	4,388	5,799	7,421	11,809
Austria	22	49	50	72
Canada	338	430	511	849
Denmark	59	111	125	184
Finland	9	11	13	22
France	640	842	1,173	1,813
Germany	1,079	1,296	1,681	2,760
Ireland	5	24	26	31
Italy	297	380	499	796
Netherlands	240	296	322	562
Norway	144	199	231	375
Portugal	18	51	62	80
Spain	165	267	331	496
Sweden	110	150	158	268
Switzerland	150	233	252	402
United Kingdom	1,112	1,460	1,987	3,099
India	182	108	131	313
Japan	744	909	1,991	2,735
Republic of Korea	57	99	114	171
United States	4,115	3,520	6,481	10,596
Total papers:	10,342			27,731

Figure 4 shows serial publications with all authors from member countries for all Programs (1969–2020) with the number of contributions on a logarithmic scale.

Table 3 shows the breakdown of first authors by country or consortium affiliation for all non-Program publication types in the database. Note that theses and dissertations are underreported to AGI and are not fully represented.

Figure 4. Number of serial publications by authors from member countries (1969–2020).

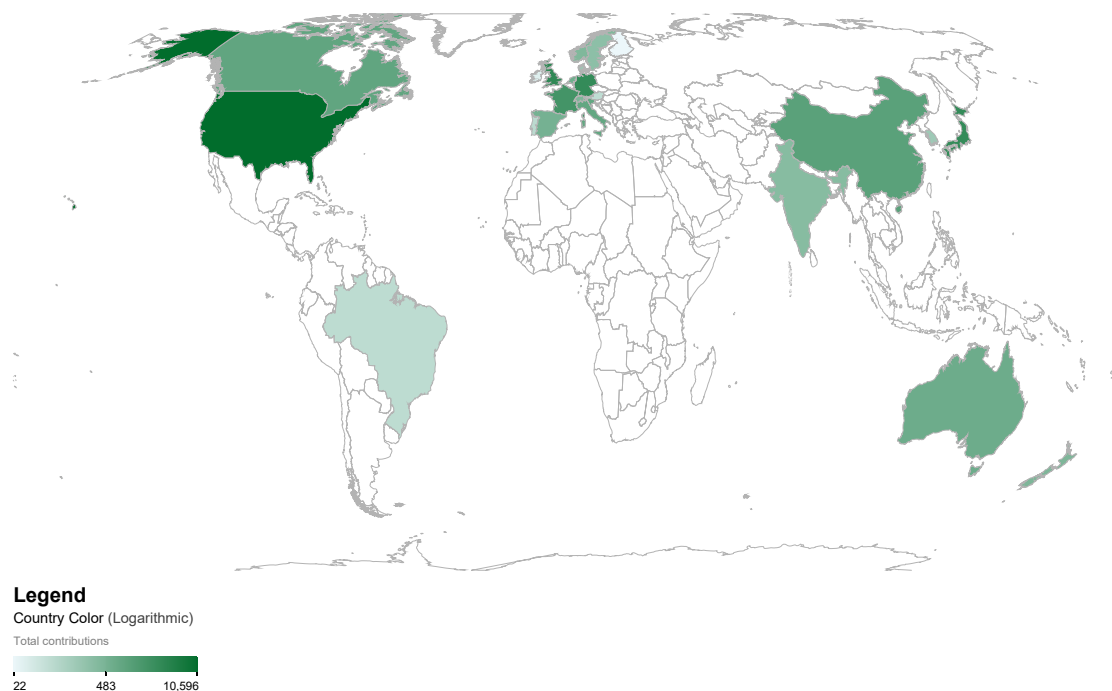


Table 3. First-authored non-Program publications by type and current funding consortium (1969–2020).

IODP member country or consortia	Serials	Misc.	Theses and dissertations		
			B.S.	M.S.	Ph.D.
Australia/New Zealand Consortium	348	506	4	6	4
Brazil	27	41	0	0	0
China	481	179	0	0	0
ECORD	4,388	5,311	15	19	111
India	182	64	0	3	3
Japan	744	870	0	0	0
Republic of Korea	57	78	0	0	0
United States	4,115	7,086	26	237	328
Totals:	10,342	14,135	45	265	446

Integrated Ocean Drilling Program and International Ocean Discovery Program (2003–2020)

Publication co-author networks

Figures 5 and 6 show co-author networks based on the serial records in the database. Each time authors publish a paper together, a line connects their countries; no line is shown if authors from the same country publish together. Each connecting line shows a minimum of 5 collaborations; line thickness indicates relative number of individual collaborations between authors from the two countries. Figure 5 includes all countries in the database that have a total of 10 or more author contributions. Figure 6 shows author contributions from current member countries.

In Figure 5, the numbers on the circles indicate the total number of times researchers from each country are listed in authorships and include first and contributing authors and multiple contributors from a single country per paper. For both Figures 5 and 6, the size of the circle indicates the relative number of authors.

The color of the circle color indicates current member country funding entities: yellow = NSF, medium blue = ECORD, teal = Japan, light blue = China, pink = ANZIC, green = India, peach = KIGAM, gray = Brazil, orange = all other nonmember countries. Line colors are a mixture of the colors between collaborating countries.

Co-author networks were generated in Gephi (<https://gephi.org>) with the help of the Convert Excel and CSV files to Networks and Give Colors to Nodes plug-ins (<http://www.clementvallois.net>).

Figure 5. Co-author networks for all authors of Program-related peer-reviewed journal articles (2003–2020).

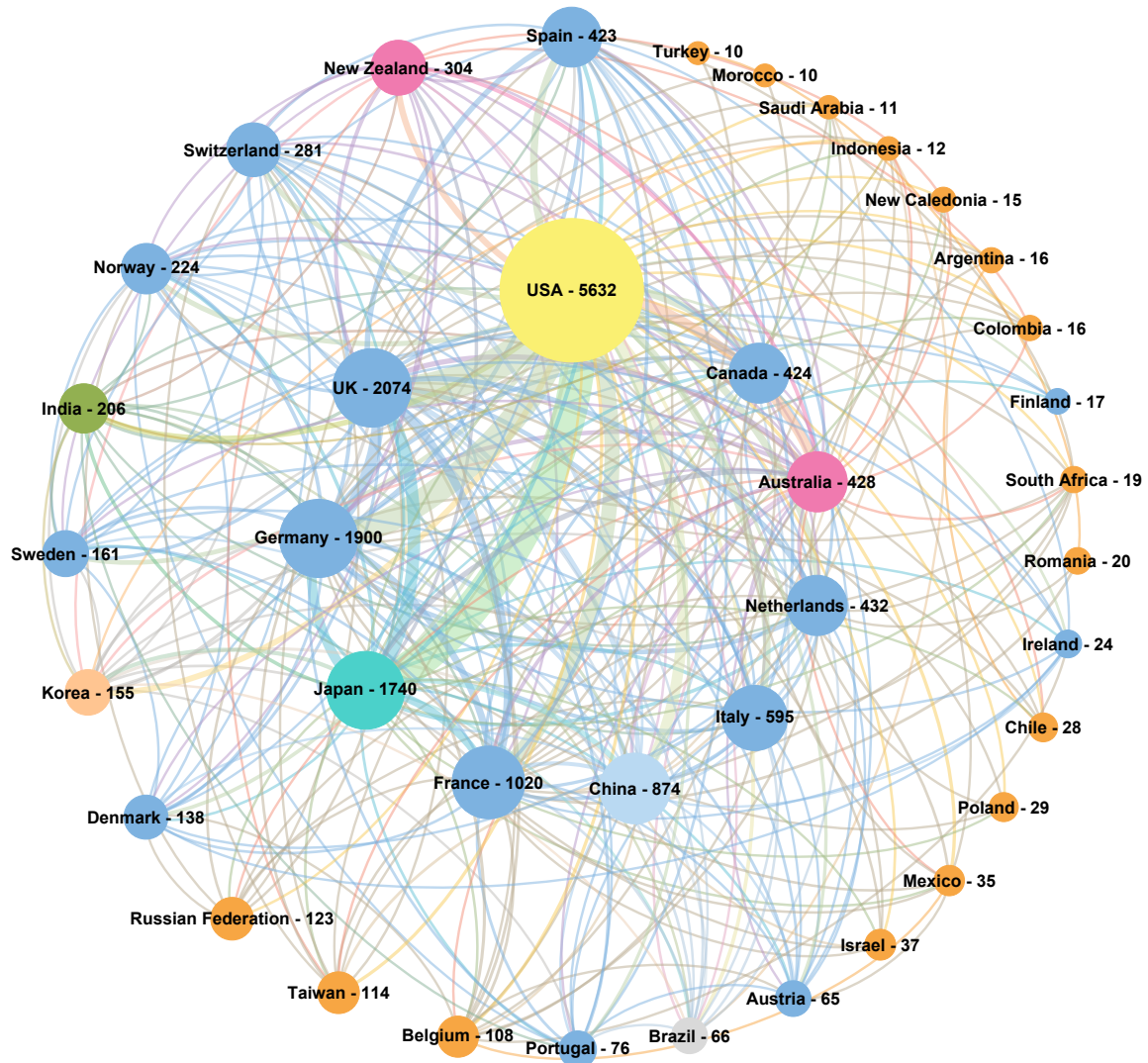
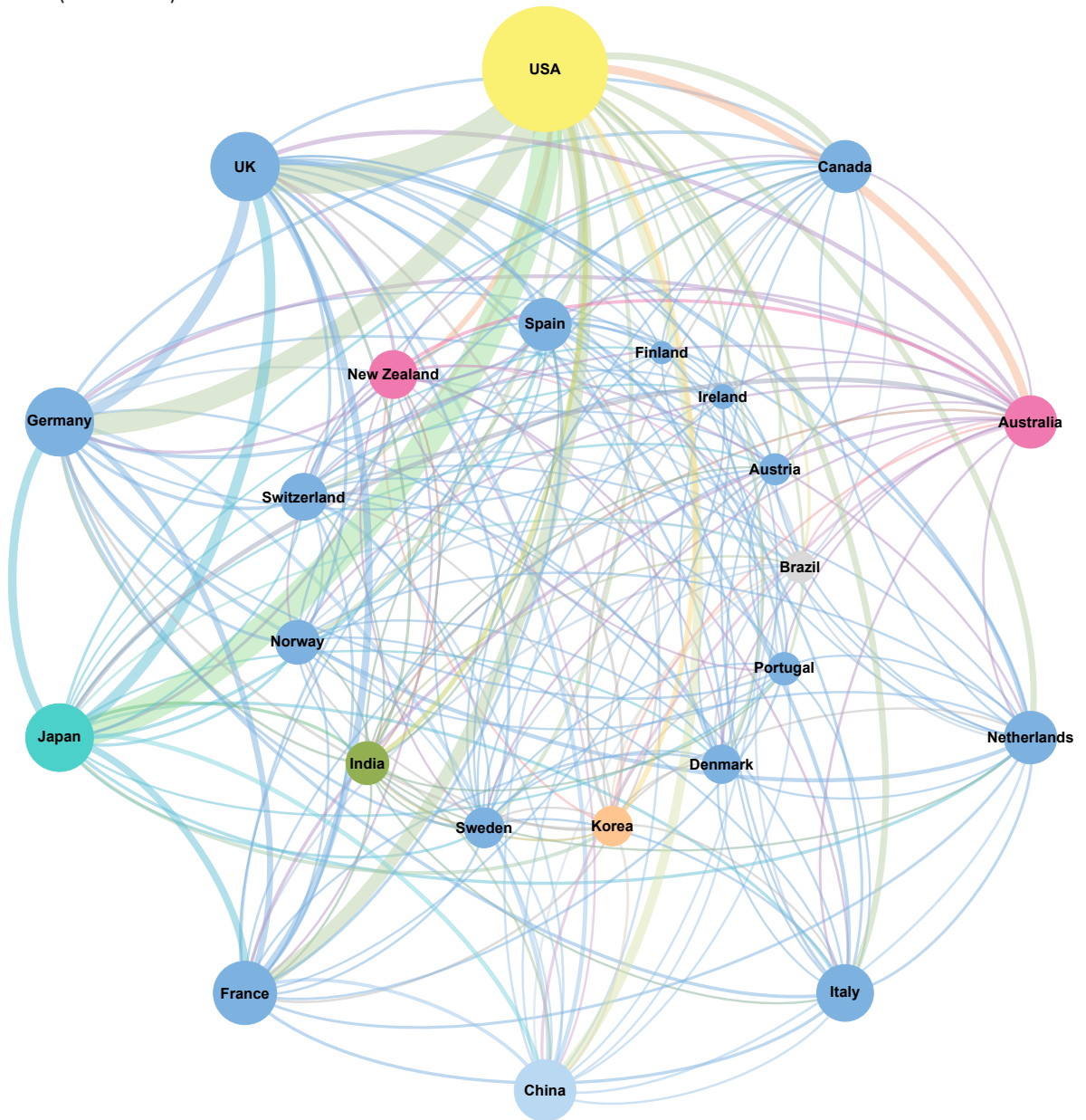


Figure 6. Co-author networks for authors of Program-related peer-reviewed journal articles from current member countries (2003–2020).



Publications by expedition

Figures 7 and 8 show the number of Program and non-Program serial publication records for all completed Integrated Ocean Drilling Program and IODP expeditions whose Expedition Reports volumes published before the end of August 2020 (Expeditions 301–372, 374–376, 380, and 381). Note that the publication tail for postcruise expedition research in both Program and serial publications extends for several years after the end of the expedition; hence, more recent expeditions have fewer publications credited to them, as illustrated in the figure.

Figure 7. Number of Program and serial publication records for Integrated Ocean Drilling Program Expeditions 301–348 (2003–2020).

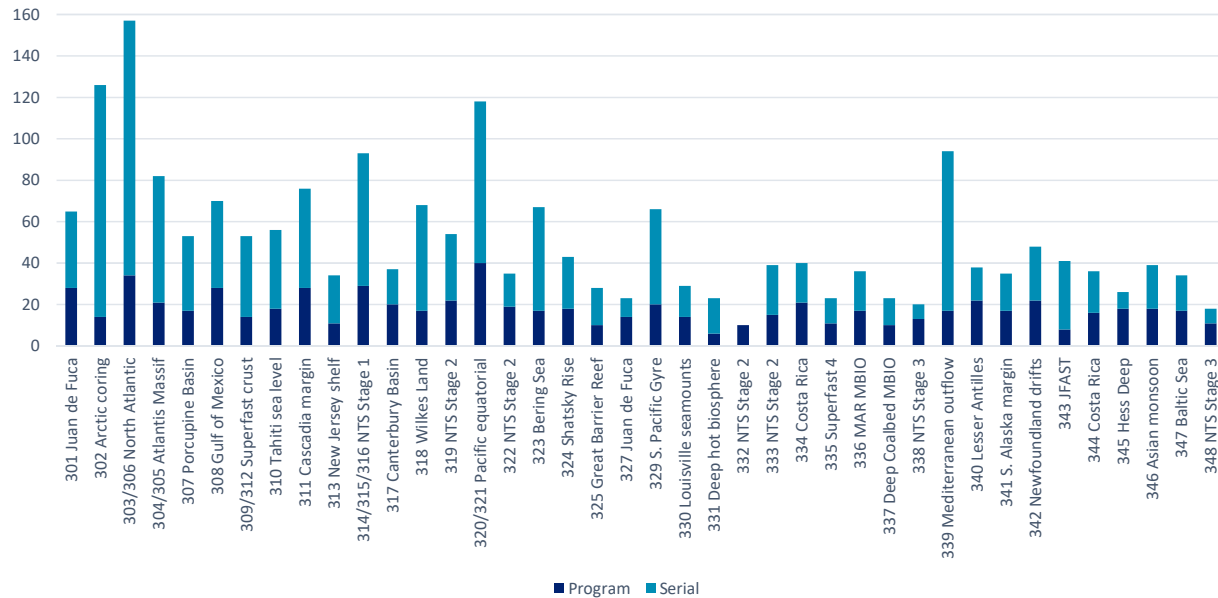
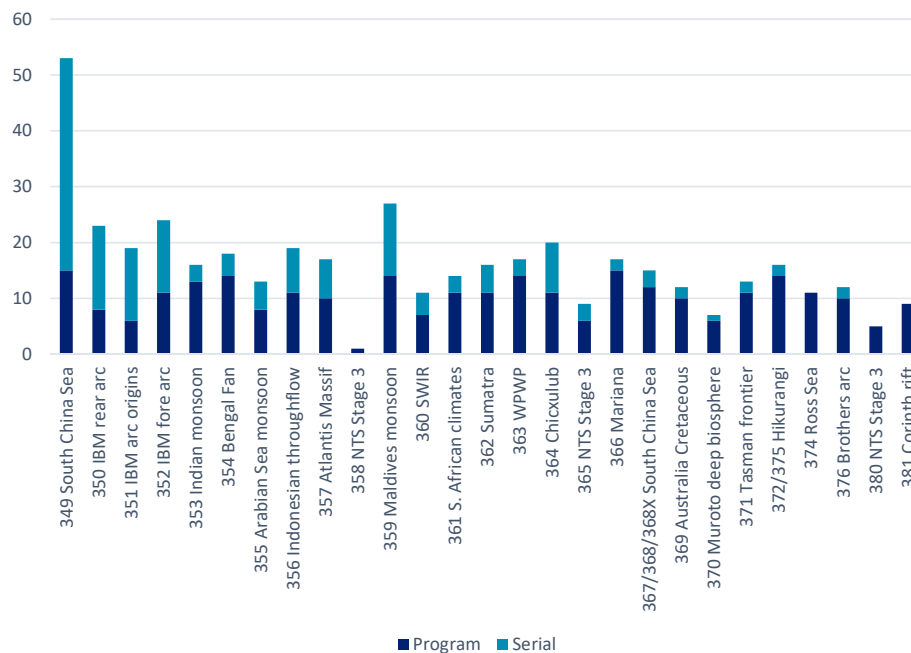


Figure 8. Number of Program and serial publication records for IODP Expeditions 349–372, 374–376, 380, and 381 (2003–2020).



Publications by Science Plan theme

Figure 9 shows Program and non-Program (all types) records related to the Integrated Ocean Drilling Program (Expeditions 301–348) and sorted by *Integrated Ocean Drilling Program Initial Science Plan* (2003–2013) themes. Initial science plan themes are tied to the primary objectives of each expedition as listed in *Developments in Marine Geology 7: Earth and Life Processes Discovered from Subseafloor Environments (A Decade of Science Achieved by the Integrated Ocean Drilling Program [IODP])*.

- Deep Biosphere: Expeditions 301, 307, 308, 311, 327, 329–331, 334, 336, 337, and 344.
- Environmental Change, Processes and Effects: Expeditions 302, 303/306, 310, 313, 317, 318, 320/321, 323, 325, 339, 341, 342, 346, and 347.
- Solid Earth Cycles and Geodynamics: Expeditions 304/305, 309/312, 314/315/316, 319, 322, 324, 326, 332, 333, 335, 338, 340, 343, 345, and 348.

Figure 9. Integrated Ocean Drilling Program publication records (all types) by Initial Science Plan theme (2006–2020).

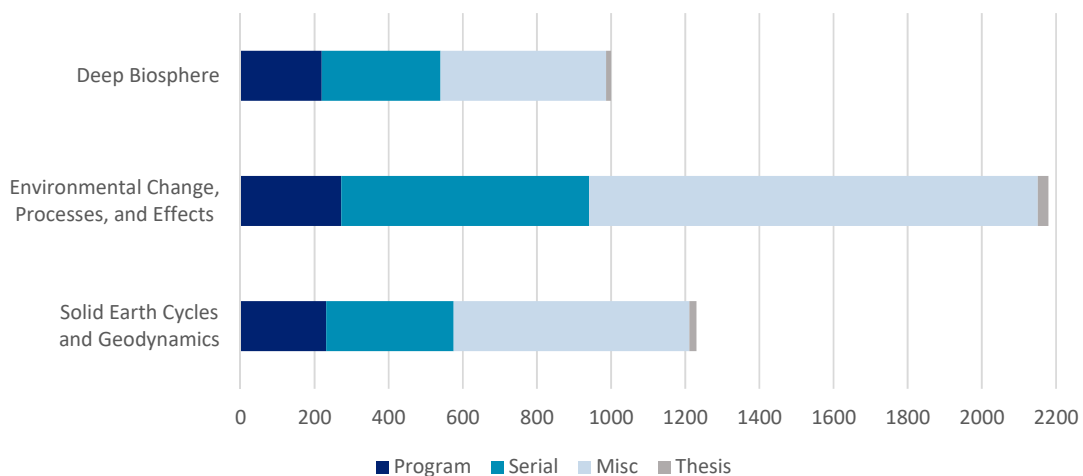
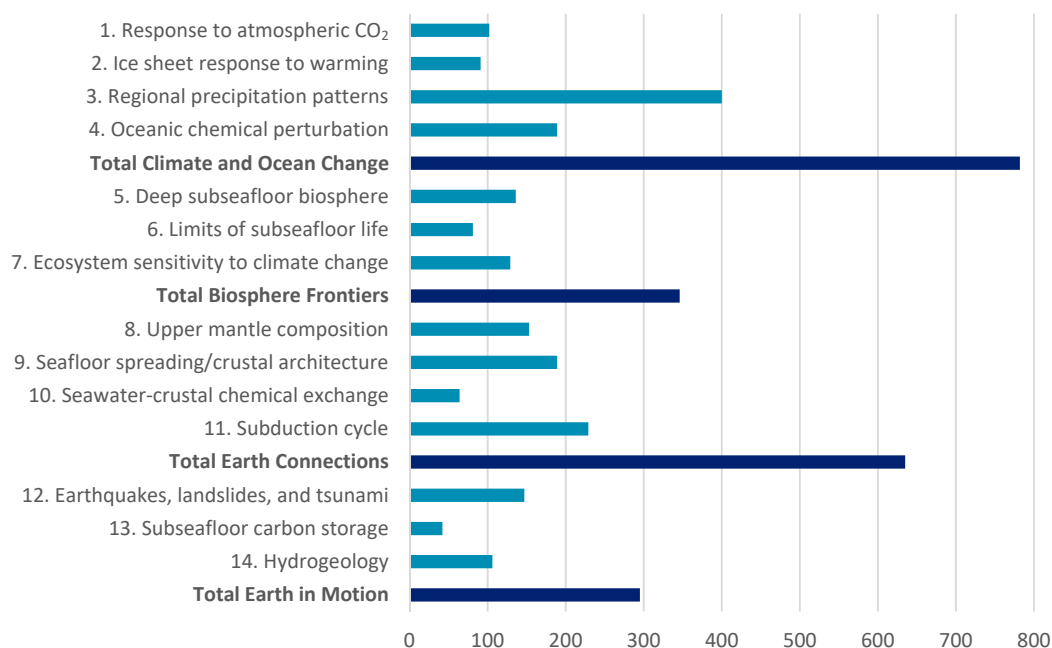


Figure 10 shows Program and non-Program serial, miscellaneous, and thesis/dissertation publication records related to IODP (Expeditions 349–372, 374–376, and 379–381) and sorted by the themes and challenges of the IODP science plan (*Illuminating Earth's Past, Present, and Future: The Science Plan for the International Ocean Discovery Program 2013–2023*). Science plan themes are tied to the primary objectives of each expedition. IODP Science Plan contains four major themes and subsidiary challenges as listed below.

- Climate and Ocean Change: Reading the Past, Informing the Future
 1. How does Earth's climate system respond to elevated levels of atmospheric CO₂? (Expeditions 361, 369, 371, 373, 377, 378, and 382)
 2. How do ice sheets and sea level respond to a warming climate? (Expeditions 359, 373, 374, 377, 379, and 383)
 3. What controls regional patterns of precipitation, such as those associated with monsoons or El Niño? (Expeditions 353–356, 359, 361, and 363)
 4. How resilient is the ocean to chemical perturbations? (Expeditions 364, 369, 374, and 378)
- Biosphere Frontiers: Deep Life and Environmental Forcing of Evolution
 5. What are the origin, composition, and global significance of deep subseafloor communities? (Expeditions 357, 366, 374, 376, and 385)
 6. What are the limits of life in the subseafloor realm? (Expeditions 370, 374, and 376)

- 7. How sensitive are ecosystems and biodiversity to environmental change? (Expedition 364)
- Earth Connections: Deep Processes and Their Impact on Earth’s Surface Environment
 - 8. What are the composition, structure, and dynamics of Earth’s upper mantle? (Expeditions 356, 357, and 360)
 - 9. How are seafloor spreading and mantle melting linked to ocean crustal architecture? (Expeditions 349, 367/368, 369, 381, and 384)
 - 10. What are the mechanisms, magnitude, and history of chemical exchanges between the oceanic crust and seawater? (Expeditions 357 and 376)
 - 11. How do subduction zones initiate, cycle volatiles, and generate continental crust? (Expeditions 350–352 and 371)
- Earth in Motion: Processes and Hazards on Human Time Scales
 - 12. What mechanisms control the occurrence of destructive earthquakes, landslides, and tsunami? (Expeditions 358, 362, 365, 372/375, 380, 381, and 386)
 - 13. What properties and processes govern the flow and storage of carbon in the subseafloor? (Expeditions 372 and 386)
 - 14. How do fluids link subseafloor tectonic, thermal, and biogeochemical processes? (Expeditions 357, 366, and 376)

Figure 10. International Ocean Discovery Program publication records (all types) by IODP Science Plan theme (2013–2020).



Alternative Impact Metrics

Citation statistics

As indexing and interconnectivity of scientific research results increase, we are better able to illustrate through citation data how often scientific publications are cited in other research articles. Citation data, in the form of number of times an article has been cited, can be accrued through several venues: Science Direct, Scopus, CrossRef, Web of Science, Plum Analytics, and others. Comprehensive citation data are

unavailable at this time because not all publishers utilize citation data compilers. For this report, we collected citation data through Google Scholar in July 2020. Review of these data shows that Program publications and non-Program serial publications containing research results from Integrated Ocean Drilling Program and IODP expeditions have been cited in other research articles more than 56,600 times between 2003 and 2020. Expedition-related science continues to be cited in other research for many years after publication. Figures 11 and 12 include available citation counts for Expeditions 301–372, 374–376, and 379–381.

Figure 11. Number of times peer-reviewed serial publications from Integrated Ocean Drilling Program expeditions were cited by other research articles (2003–2020).

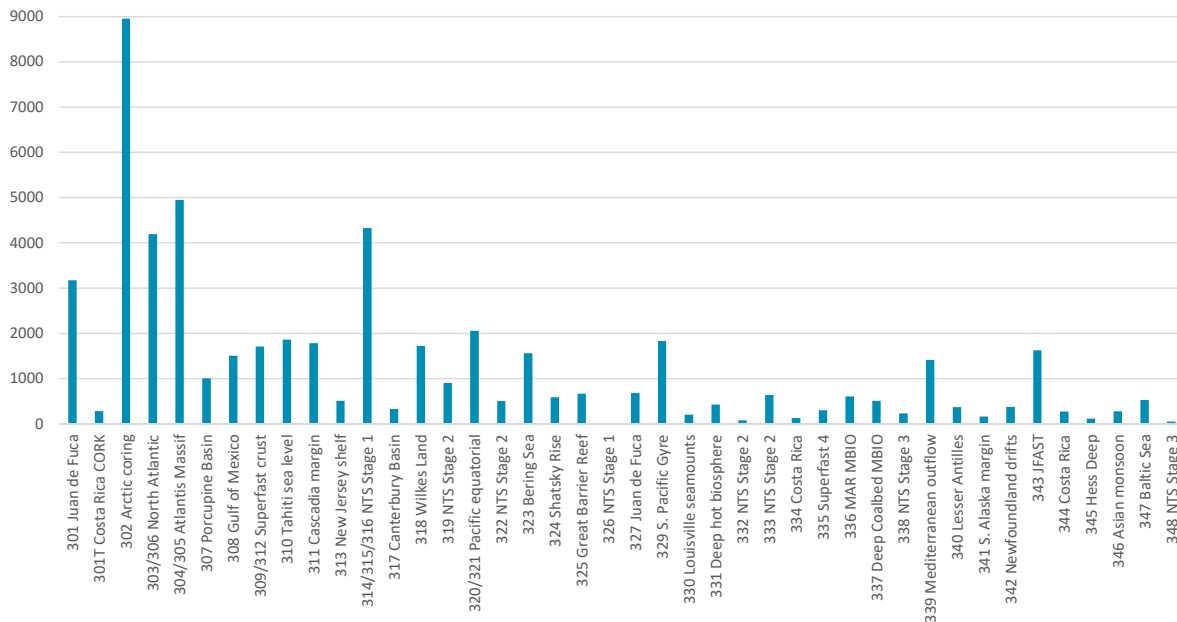


Figure 12. Number of times peer-reviewed serial publications from International Ocean Discovery Program expeditions were cited by other research articles (2003–2020).

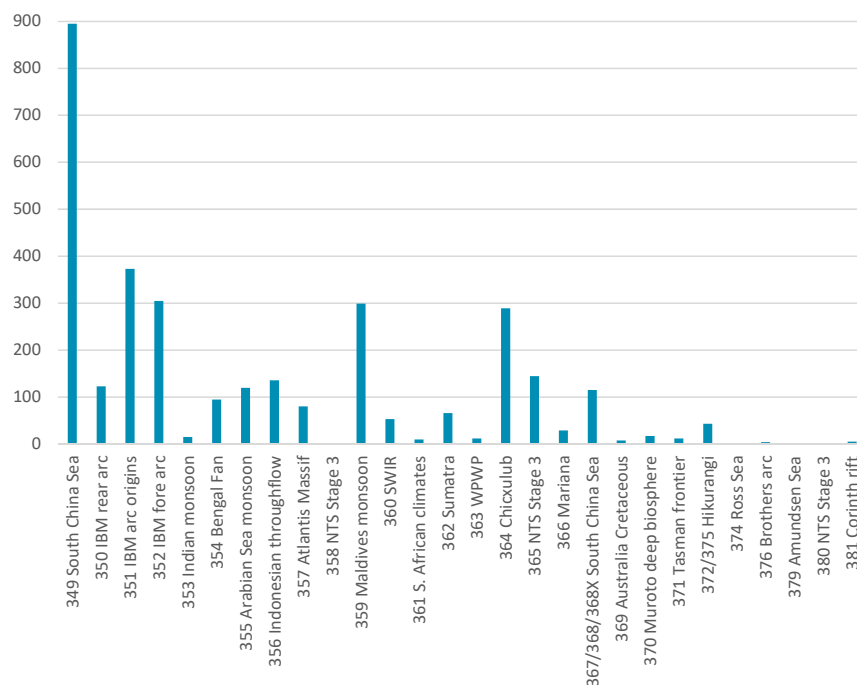











Table 4 lists the ODP, Integrated Ocean Drilling Program, and IODP expedition-related papers that have been most cited as of July 2020. It takes several years for papers to be published, and even more time for them to build up a high cited-by number; all of the most-cited papers are related to volumes published in 2011 or before. All of them are published in the top journals by impact factor, as shown in Figure 3. The Altmetric score for each paper is listed (? = no score at time of publication). See the next section for a discussion of Altmetric scores.




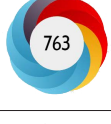

Table 4. Top cited Program-related serials as of July 2020 with corresponding Altmetric scores. Click on the graphic to view the live Altmetric data.

Article	Citations (N)	Altmetric score
Sluijs, A., Schouten, S., Pagani, M., Woltering, M., Brinkhuis, H., Sinninghe Damsté, J.S., Dickens, G.R., et al., 2006. Subtropical Arctic Ocean temperatures during the Palaeocene/ Eocene Thermal Maximum. <i>Nature</i> , 441(7093):610–613. https://doi.org/10.1038/nature04668	675	 88
Kallmeyer, J., Pockalny, R., Adhikari, R.R., Smith, D.C., and D’Hondt, S., 2012. Global distribution of microbial abundance and biomass in subseafloor sediment. <i>Proceedings of the National Academy of Sciences of the United States of America</i> , 109(40):16213–16216. https://doi.org/10.1073/pnas.1203849109	634	 130
Lipp, J.S., Morono, Y., Inagaki, F., and Hinrichs, K.-U., 2008. Significant contribution of Archaea to extant biomass in marine subsurface sediments. <i>Nature</i> , 454(7207):991–994. https://doi.org/10.1038/nature07174	560	 4
Moran, K., Backman, J., Brinkhuis, H., Clemens, S.C., Cronin, T., Dickens, G.R., Eynaud, F., et al., 2006. The Cenozoic palaeoenvironment of the Arctic Ocean. <i>Nature</i> , 441(7093):601–605. https://doi.org/10.1038/nature04800	560	 28
Jakobsson, M., Macnab, R., Mayer, L., Anderson, R., Edwards, M., Hatzky, J., Schenke, H.W., and Johnson, P., 2008. An improved bathymetric portrayal of the Arctic Ocean: Implications for ocean modeling and geological, geophysical and oceanographic analyses. <i>Geophysical Research Letters</i> , 35(7):L07602. https://doi.org/10.1029/2008GL033520	491	 ?
Grimes, C.B., John, B.E., Kelemen, P.B., Mazdab, F.K., Wooden, J.L., Cheadle, M.J., Hanghøj, K., and Schwartz, J.J., 2007. Trace element chemistry of zircons from oceanic crust: a method for distinguishing detrital zircon provenance. <i>Geology</i> , 35(7):643–646. https://doi.org/10.1130/G23603A.1	464	 ?
Deschamps, P., Durand, N., Bard, E., Hamelin, B., Camoin, G., Thomas, A.L., Henderson, G.M., Okuno, J., and Yokoyama, Y., 2012. Ice-sheet collapse and sea-level rise at the Bølling warming 14,600 years ago. <i>Nature</i> , 483(7391):559–564. https://doi.org/10.1038/nature10902	404	 69
Pagani, M., Pedentchouk, N., Huber, M., Sluijs, A., Schouten, S., Brinkhuis, H., Sinninghe Damsté, J.S., Dickens, G.R., and Expedition 302 Scientists, 2006. Arctic hydrology during global warming at the Palaeocene/Eocene Thermal Maximum. <i>Nature</i> , 443(7103):671–675. https://doi.org/10.1038/nature05043	391	 15
Moore, G.F., Bangs, N.L., Taira, A., Kuramoto, S., Pangborn, E., and Tobin, H.J., 2007. Three-dimensional splay fault geometry and implications for tsunami generation. <i>Science</i> , 318(5853):1128–1131. https://doi.org/10.1126/science.1147195	365	 11
Frost, B.R., and Beard, J.S., 2007. On silica activity and serpentinization. <i>Journal of Petrology</i> , 48(7):1351–1368. https://doi.org/10.1093/petrology/egm021	302	Not available

Altmetric scores

Altmetric scores demonstrate the more immediate impact of papers by tracking mentions of them by news outlets, blogs, Wikipedia pages, and other social media. Table 5 lists the DSDP, ODP, Integrated Ocean Drilling Program, and IODP expedition-related serials with the highest Altmetric scores as of July 2020. All of them are published in the top-ranked journals by impact factor, as shown in Figure 3. Altmetric score colors represent the following sources: red = news outlets, orange = blogs, light blue = Twitter, dark blue = Facebook, gray = Wikipedia, purple = policy source, plum = Google+, light blue = Reddit, light green = video uploader, and pink = research highlight platform. Visit the Altmetric website for more information about Altmetric scores (<https://www.altmetric.com>).

Table 5. Expedition-related papers with the highest Altmetric scores as of 7 August 2020. Click on the graphic to view the live Altmetric data and links to news articles and social media stories about each article.

Article	Expedition	Citations (N)	Altmetric score
Collins, G.S., Patel, N., Davison, T.M., Rea, A.S.P., Morgan, J.V., Gulick, S.P.S., the IODP-ICDP Expedition 364 Science Party, and Third-Party Scientists, 2020. A steeply-inclined trajectory for the Chicxulub impact. <i>Nature Communications</i> , 11:1480. https://doi.org/10.1038/s41467-020-15269-x	IODP 364	1	 1518
Gulick, S.P.S., Bralower, T.J., Ormo, J., Hall, B., Grice, K., Schaefer, B., Lyons, S., et al., 2019. The first day of the Cenozoic. <i>Proceedings of the National Academy of Sciences of the United States of America</i> , 116(39):19342–19351. https://doi.org/10.1073/pnas.1909479116	IODP 364	20	 1007
Morgan, J.V., Gulick, S.P.S., Bralower, T., Chenot, E., Christeson, G., Clayes, P., Cockell, C., et al., 2016. The formation of peak rings in large impact craters. <i>Science</i> , 354(6314):878–882. https://doi.org/10.1126/science.aah6561	IODP 364	100	 988
Henehan, M.J., Ridgwell, A., Thomas, E., Zhang, S., Alegret, L., Schmidt, D.N., Rae, J.W.B., et al., 2019. Rapid ocean acidification and protracted Earth system recovery followed the end-Cretaceous Chicxulub impact. <i>Proceedings of the National Academy of Sciences of the United States of America</i> , 116(45):22500–22504. https://doi.org/10.1073/pnas.1905989116	IODP 364	26	 906
Hull, P.M., Bornemann, A., Penman, D.E., Henehan, M.J., Norris, R.D., Wilson, P.A., Blum, P., et al., 2020. On impact and volcanism across the Cretaceous-Paleogene boundary. <i>Science</i> , 367(6475):266–272. https://doi.org/10.1126/science.aay5055	IODP 342	17	 820
Sager, W.W., Zhang, J., Korenaga, J., Sano, T., Koppers, A.A.P., Widdowson, M., and Mahoney, J.J., 2013. An immense shield volcano within the Shatsky Rise oceanic plateau, northwest Pacific Ocean. <i>Nature Geoscience</i> , 6:976–981. https://doi.org/10.1038/ngeo1934	IODP 324 with ODP 192 and 198	82	 809
Alvarez, S.A., Gibbs, S.J., Bown, P.R., Kim, H., Sheward, R.M., and Ridgwell, A., 2019. Diversity decoupled from ecosystem function and resilience during mass extinction recovery. <i>Nature</i> , 574(7777):242–245. https://doi.org/10.1038/s41586-019-1590-8	IODP 364	5	 763
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