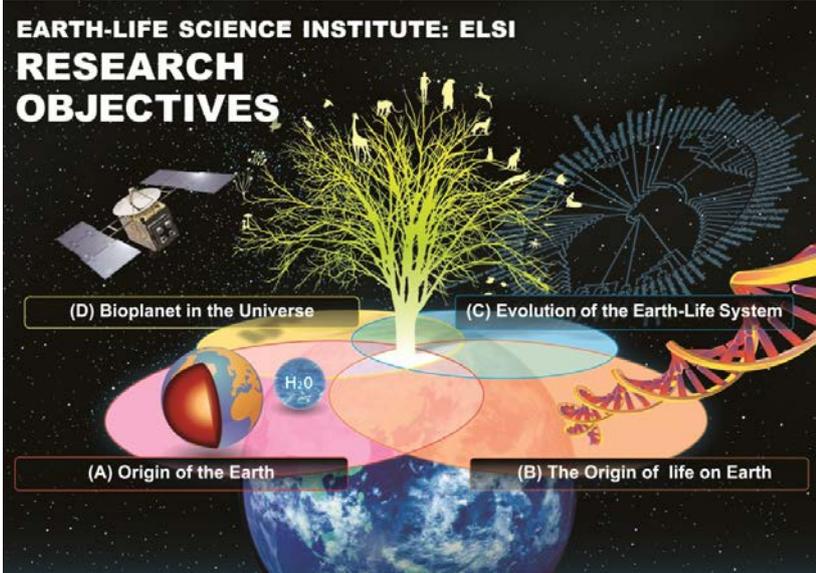


Summary of Proposal

Host institution	National University Corporation Tokyo Institute of Technology
Chief entire-project officer (Head of host institution)	Yoshinao Mishima , President
Chief center-project officer	Kei Hirose , Professor Graduate School of Science and Engineering, Tokyo Institute of Technology
Center director	Kei Hirose , Professor Graduate School of Science and Engineering, Tokyo Institute of Technology
Center name	<i>Earth-Life Science Institute (ELSI)</i>
Project Summary	<p>ELSI aims to answer the fundamental question "when and where did life originate and how did it evolve?" This question, which originated with the Greek philosophers, has been one of the most important topics of natural science. We will focus our research on addressing the unique environments on the early Earth that gave birth to life and their subsequent changes, with the main aim to study the origin and early evolution of life and persistent ecological systems in their geological context. We will also approach the primordial environment of the Earth through explorations of deep-sea microbial ecosystems and extraterrestrial primitive asteroids. In addition, we will critically examine the universality of these processes, to determine the uniqueness of our planet, with implications for the search for extraterrestrial life, both in the solar system and beyond.</p>
Mission statement and/or Center identity	<p>So far, discussions about the origin of life on Earth have been mostly limited to the biochemistry of proto-life forms. While the Earth environment has been described as a "cradle of life", the image of a "cradle" points to a supporting background role, rather than a dynamic interplay. In ELSI, we want to radically broaden these discussions by focusing equally strongly on both sides of Earth and Life. For one thing, life is preserved through a continuous exchange of matter and energy with the surrounding environment. For another, it is a two-way interaction: as soon as life forms are present, they start to influence the environment, just as the environment is influencing life. Our basic outlook is reflected in the name of our proposed center: ELSI stands for Earth-Life Science Institute, in which Earth sciences and Life sciences will be equally represented.</p> <p>In contrast to NASA's Astrobiology Institute whose research topics are broadly similar to ours, we emphasize 1) the role of the Earth as a whole in the origin and evolution of life, based on the past achievement of collaborative studies at Tokyo Tech; and 2) the fact that ELSI will not be a virtual institute, but based in one building, with vigorous internal communications through a series of daily, weekly, and monthly events, following the Program for Interdisciplinary Studies at the Institute for Advanced Studies (IAS) in Princeton as a model. This IAS program will act as a satellite center for ELSI.</p> <p>We are planning to build up a strong interdisciplinary program within ELSI. This will attract a wide variety of top scientists to visit ELSI to interact with members there and also with each other. We do not want to define job specifications too strongly beforehand. Rather, we prefer to attract top scientists first, and then to finetune the research program around their skills and interests.</p> <p>We will combine our research with outreach and education. Spacecrafts such as Hayabusa and Hayabusa-2, and questions about the formation of Earth and the origin of life, as well as extraterrestrial life are of strong interest to the general public, and thus perfect for outreach. As for education, we will create a Summer Internship Program for high school students, based on nation-wide competitions in high schools in Japan. These activities will also help not only ELSI but also its host, Tokyo Tech, to further increase both its international and its domestic visibility.</p>
Target research field	<p>Target research field: Interdisciplinary Research on Solid-Earth Science, Planetary Science, Geology, Environmental Biology, and Microbial Genome Science</p> <p>Recent progress: Major progresses has been made recently in the three areas of early Earth</p>

	<p>environments, primordial ecological systems, and extraterrestrial life: 1) laboratory experiments that reproduce the conditions at the beginning of the Earth's history, 2) investigations of ecological systems under extreme environments, and 3) the study of Earth-like exoplanets. Our PIs have made major contributions to the progress in all of these areas.</p> <p>Our superiority:</p> <p>Our team has proven to be world-leading in the areas of our proposed research. We will study the unique environments on the early Earth by combining the research utilizing high-pressure/high-temperature experiments, theory of planet formation, and decoding the Earth's history, all of which are areas in which research at Tokyo Tech is ahead of that at other places, nationally and internationally. In addition, Japanese scientists are also playing a leading role in the research of microbial ecological systems under extreme conditions.</p>
<p>Research objectives</p>	<p>Our research will answer the following scientific questions:</p> <ul style="list-style-type: none"> - What were the environments at the beginning of the Earth's history? - When and where did the primordial ecological system originate? - How did the Earth and the Universe affect the evolution of life? - How unique is our planet? <p>We will also contribute to the planning of explorations of the solar system and observations of exosolar systems based on the outcome of our research.</p> 
<p>Outline of management</p>	<p>The Center will be established as an independent organization inside Tokyo Tech. The Center Director will have the authority to make all decisions related to ELSI including the appointment of all staff members, budget implementation, etc, with advice from the Steering Committee and the International Advisory Board. The Center will create a research-oriented English-based administrative system. In addition to Research Advisors who provide a wide range of support to researchers, a Life Advisor will be assigned to each non-Japanese family. Research Communicators will be in charge of overall outreach activities, organizing regular meeting with journalists, lecture series for the general public, and a Summer Internship Program for high-school students.</p>
<p>Researchers and other center staffs, satellites, partner institutions</p>	<p>[Principal Investigators] 16 (incl. 6 non-Japanese) [Total number of researchers] 76 (incl. 25 non-Japanese) [Total number of staffs] 116 (incl. research assistant, excluding short visitors) [Timing for achieving these staffing goals] October, 2015 [Main principal investigators] (current affiliation) Piet Hut (Inst. Adv. Study, Princeton), Joseph L. Kirschvink (Caltech), Renata M. Wentzcovitch (Univ. Minnesota), Jack Szostak, Lisa Kaltenegger (Harvard Univ.), John W. Herlund (Univ. California, Berkeley), Tetsuo Irifune (Ehime Univ.), Hitoshi Kuninaka, Masaki Fujimoto (JAXA), Ken Takai (JAMSTEC), Kei Hirose, Shigeru Ida, Jun-ichiro Makino, Shigenori Maruyama, Naohiro Yoshida, Ken Kurokawa (Tokyo Tech) [Satellite organizations] Ehime University, Institute for Advanced Study in Princeton, Harvard University [Partner institutions] 38 institutions in 11 countries</p>

Administrative director	Dr. Kiyoshi Nakazawa , Dedicated Professor, Ex-Dean of Graduate School of Science, Tokyo Institute of Technology												
Outline of research environment	<ul style="list-style-type: none"> - The Center will ensure that all PIs can concentrate on their research. Each PI has his/her own research group with at least two post-docs. Both Research Advisors and Life Advisors will provide a full range of support to non-Japanese scientists and their families. PIs from the host institute will be reassigned to ELSI, and exempted at least from the duty of teaching undergraduate students. - The Center will provide each PI from abroad with start-up fund of JPY10 to 20M. Additional support may be given upon discussion with the Center Director. - English-based research-orientated administrative systems will be created through a unique new system. The administrators will be informed of the latest research results, will be sent to oversea satellite institute to learn efficient administration, and will be evaluated annually from a researcher's point of view. - Evaluation of the research activities by each scientist will be made on the basis of publication in academic journals and presentation at the Annual Evaluation Workshop. Contributions to other activities of the Center such as public outreach will be also considered. These will reflect in the annual salary renewal. - The university has reserved sufficient research space (about 1,500 m² from start and additionally up to approximately 2100 m² by FY2015) for the Center at its Ookayama Campus, close to the building of the Department of Earth and Planetary Sciences. We can start research as soon as the Center is established. 												
Outline of indicators for evaluating a center's global standing	We can evaluate our research activity and impact using the database provided by Thomson Reuters. The data from 1996 to 2010 show that the average number of papers per faculty member (PI for ELSI) per year is much larger than those for the Department of Earth and Planetary Sciences at Japanese top universities, and comparable to those for world-leading institutes. Most importantly, the papers published by our PIs have been cited more times than those reported from the world-leading universities. In the next five to ten years, ELSI will become the top institute in the world in both of the indicators.												
Securing research funding	The 10 Japanese PIs have acquired research funds of JPY670M/year on average during 2007-2011 and about JPY970M/year in average for 2012 and 2013. Additionally, the 8 Japanese non-PI researchers have received another JPY~200M/year in these periods. These past records clearly show that our team can secure research funds exceeding that of the WPI grants (about JPY700M/year). With the competitive research funds acquired by non-Japanese PIs and dedicated assistant/associate professors, we expect to obtain more than JPY1500M/year by FY2019.												
Exploiting the results of previously-initiated center-building efforts	<p>Program name: Global Center of Excellence program (G-COE) Project title: From the Earth to "Earths" Related to this G-COE program, the university provided about JPY4M in 2012 and a research space of about 260 m².</p>												
Appropriations plan (Exchange Rate: JPY/USD=80)	FY	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total (\$ millions)	
	WPI grant	3.756	6.625	7.625	7.625	7.625	7.625	7.625	7.625	7.625	7.625	71.381	
	Funding for previously-initiated center-building efforts (if any)	0.501	1.122	1.125	1.125	1.125	1.125	1.125	1.125	1.125	1.125	10.624	
	Total	4.257	7.747	8.750	8.750	8.750	8.750	8.750	8.750	8.750	8.750	82.006	
Summary of host institution's commitment	<ul style="list-style-type: none"> - The establishment of the WPI institute matches the guidelines for long-term goal "Vision 2009" as well as the university's mid-term goal, and therefore the university will provide long-term full support to ELSI. Moreover, the university will add the description of the WPI to the mid-term plan immediately in the future. - The university will provide ELSI with JPY90M every year after FY2014 from the President's Discretionary Fund to compensate for the ending of the support from the Global Center of Excellence (G-COE) program. - Appropriate research space for ELSI has been already reserved by the university at its Ookayama Campus, very close to the building for the Department of Earth and Planetary Sciences. 												

	- Already before the end of the WPI program, Tokyo Tech as a whole will internally adopt widely those parts of ELSI's innovative systems that will have proven to be effective.
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