IODP Proposal Cover Sheet

☐ **New** ☐ **Revised** ☐ **Addendum**

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Title:	Development of a new seafloor sensor for IODP Proposal 621
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Area:	Proposal 621 MBTS-3A

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Permission to post abstract on IODP-MI Sapporo Web site: ■ Yes ☐ No

Abstract: (*400 words or less)*

We are in the process of developing a new instrument system to make subsurface time series physical measurements in IODP boreholes. Approval to deploy a prototype system as part of the installation of the borehole test facility in Monterey Bay outlined in IODP Proposal 621, is requested in this Ancillary Project Letter. This system would be deployed in a pilot hole adjacent to the proposed MBTS-3A site in IODP Proposal 621. We estimate that this operation will require scheduling 3 additional days of JOIDES Resolution shiptime.

The instrument, called SCIMPI (Simple Cabled Instrument for Measuring Parameters In-situ), is intended to be a partial replacement for the traditional CORK systems that have been used in ODP/IODP boreholes. SCIMPI will utilize largely established technology in a novel way to permanently place strings of subsurface sensors in uncased boreholes that will allow the capture of time series data at various depths below the seafloor. The sensors can be monitored indefinitely without the need to service the system with a drillship. The SCIMPI moniker is quite appropriate because this new sensor system will cost considerably less than ODP CORKs and take much less ship time to deploy, while providing similar data.

Our desire is to deploy one of these systems in Monterey Bay about 10 m from the proposed permanent casing associated with geo-hydrology site (MBTS-3A), both as a proof of concept and to collect critical data for the evaluation of future experiments and engineering tests.

Scientific Objectives: (*250 words or less*)

Introduction - The initial science plan of the IODP promised to push innovative research programs that focus on the study the seafloor as a dynamic system. The installation of long-term observatories that make temporal measurements of physical, chemical, and biological processes is critical to achieve this goal. Unfortunately, only limited progress has been made toward this effort in the first few years of the IODP. Thus, the IODP is arguably already behind on the development, testing, and installation of truly new sub-seabed measurement systems that are critical to advancing the ocean observatory concept.

In this note, we describe a new concept for sub-seafloor observatories that builds on ODP experience and has three major advantages: (1) the costs associated with the SCIMPI instrument system are estimated to be a fraction of the "traditional" ODP CORK systems with little reduction in the data that can be obtained; (2) the design is easy to install, and it does not require expensive hole completions; and (3) it incorporates already-proven components from industry, which reduces the design and testing costs.

Please describe below any non-standard measurements technology needed to achieve the proposed scientific objectives.

While the sensors and data logging are standard, the instrument packaging and deployment strategy represents a radical departure from the standard techniques of obtaining time-series data in boreholes.

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
MBTS-3A	36° 43.0506'N; 122° 10.5631'W	831	350 m		350	Installation of SCIMPI (This APL is not for a new site, but for an additional hole at MBTS-3 site given in IODP Proposal 621).

History of this APL - An earlier version of this Ancillary Proposal Letter was submitted in March 2005 and assigned APL # 666. At that time the installation of the Monterey Bay sites was scheduled to occur from the *JOIDES Resolution* in October 2005. This would have required a considerably compressed development schedule for the SCIMPI if it were to be deployed on this expedition. While the SPC review expressed strong support for the concept of developing the SCIMPI and encouraged this to be pursued, the development schedule was viewed as being unrealistic. However, delays associated with the permitting process caused the entire Monterey Bay program to be removed from the *JOIDES Resolutions* Phase I schedule. We are anticipating that this expedition will be rescheduled for early in Phase II.

A proposal to develop this tool was also submitted to the US NSF with a plan to deploy the prototype on IODP the October 2005 Monterey Bay Expedition. Shortly after the Monterey Bay Expedition was removed from the 2005 JR schedule, this proposal was declined, again largely because the development schedule was viewed as unrealistically aggressive. However, the concept of developing a SCIMPI system was strongly endorsed. A revised proposal was resubmitted to the US-NSF for the August 15, 2005 deadline. Because a number of technical issues associated with the development of a new borehole instrument system (especially as a third-party tool) are not addressed in this APL, we are making the text of the NSF proposal available (http://www.mbari.org/staff/paull/scimpi_nsfproposal_summer05.pdf).

SCIMPI Concept and Need - The objective is to provide sensor strings for IODP boreholes to make time series measurements of the physical properties within the formation that can be deployed as inexpensively and easily as possible. The academic deep-sea drilling community's experience with making such measurements has been developed using cased holes. This is a consequence of how the CORK efforts evolved. However, there is considerable expense to the IODP to fabricate the re-entry cone and casing string, followed by several days of drill ship time to install the seafloor infrastructure required for a CORK deployment. Moreover, the CORK hardware represents an additional substantial expense. Thus, we are attempting to develop another approach to collect similar data that will eliminate the expensive infrastructure, require less ship time to deploy, and considerably less science dollars.

The SCIMPI will involve permanently deploying an instrument string within an uncased open borehole. Sensor packages along this instrument string will be connected internally with a power/data transmission cable. A buoyant cable (like the tethers commonly used on ROVs) will be used and additional floatation will be added at the top of the sensor string to keep the instrument string taut as it is deployed within the borehole. The sensors spaced along a cable will become sealed in the hole as the formation closes around it over time.

The SCIMPI sensor string will be one pre-assembled and pre-tested piece, slightly longer than the borehole's planned total depth (e.g., 360 m at site MBTS-3A). An anchor weight will be attached at its bottom. At its upper end the cable will terminate with enough floatation to keep the SCIMPI string taut and have an ROV-mateable underwater connector at the end of the conductive cable.

The SCIMPI will be deployed from the drillship by lowering it on a wireline into a borehole through the drill pipe. This will be done after a hole has been washed in to TD (e.g., 350 m at MBTS-3A) and the drill pipe pulled back a few sections. When the drill pipe is still ~320 m below the mudline, the SCIMPI will be fed into the open drill pipe on the drill ship. The entire SCIMPI sting will have a maximum diameter (7.6 cm) and streamlined shape that will allow it to pass through the bit and into the open hole. When the anchor hits the bottom of the hole and load is taken off the wire line, the SCIMPI string will be released in the hole using a standard Schlumberger wireline release. Then, the drill string will be tripped leaving the SCIMPI anchored at the base of the hole. In some regards the SCIMPI will be similar to a traditional oceanographic mooring, except it will be anchored within subsurface (rather than on the seafloor), and the sensors are hardwired together. When the drill ship is finished there should be 10 m or more of SCIMPI cable extending out of the seafloor, held up by the syntactic foam floatation.

We will visit the SCIMPI site shortly after deployment with the ROV *Ventana*. During this dive: (1) a seafloor template will be attached which fixes the cable to the mudline, (2) the floatation will be removed allowing the section of cable that extends above the seafloor to settle to the seafloor, and the connector will be plugged into a data logging package that will be brought to the seafloor by the ROV. This will begin the data-logging phase.

The SCIMPI concept provides a way to collect subsurface temperature and pressure, essentially the same data as traditional CORK systems. We will also be recording resistivity to monitor the process of formation closure. Initially, data will be collected at a very high frequency for a few weeks. At this point the autonomous data logger/battery package will be recovered to assess the initial hole conditions. We anticipate that it will either be quickly replaced by another autonomous logging package or connected directly to the MARS cable, depending on the status of the initial data and the readiness of the MARS cable and cable connection infrastructure.

The proposed SCIMPI sensor technology is largely commercial off-the-shelf (COTS). Components are taken from cone penetration test (CPT) equipment, which has been routinely used for over 50 years in geotechnical practice, and sensor technology used in the wireline logging community. The wireline logging industry has developed sensor packages, many of which have been adapted to CPT equipment for onshore use (e.g., environmental applications). Our approach is to use COTS CPT communication technology of Applied Research Associates (ARA), and COTS sensors modified so that the sensor packages are distributed along each SCIMPI (Figure 1). The sensors we initially propose to install include: temperature, resistivity sensors and pore pressure transducers to prove the concept. However, other sensors (e.g., geophones) can easily be added later.

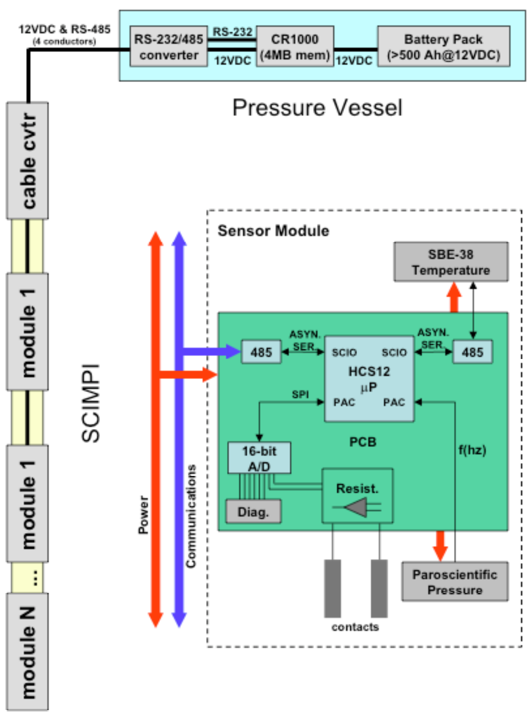

Figure 1: Schematic block diagram showing organization of the SCIMPI sensor modules (below the seafloor) and the power/data system that is housed in a pressure vessel on the seafloor. Inset is the block diagram of a SCIMPI sensor module internal layout.

Signals from each of the sensors will be transmitted through the cable and recorded by a computer data acquisition system and battery power pack located on the seafloor. The design of the topmost section that extends from the last sensor and includes the wet mateable connector, floatation, and connects to the Schlumberger wireline release will be developed by MBARI. The power/data pack will have a wet-mateable connector at the power/signal cable termination so that the package can be removed and replaced by either a new seafloor power pack and data logger or interfaced to a submarine cable. In the case of the Monterey Bay test deployment site, we anticipate that this SCIMPI can ultimately be connected to the MARS cable and provide data for the life of the SCIMPI system with no additional servicing. Thus, in principle, this could result in a 25-year time series record of subsurface temperature, resistivity, and pressure.

Economic Benefits - The development of sub-seafloor observing systems (e.g., CORKs) are among the most commonly cited achievements of the ODP. The existence of the CORK technology has stimulated an escalation in the sophistication of the science targets that are being proposed for future IODP legs. While individual CORK deployments were once rare during the ODP, it is now common for multiple CORKs to be included in an individual IODP proposal. However, CORK systems are expensive and require considerable servicing effort. When the installation of CORKs was rare, the higher additional leg costs were more easily accommodated in the annual program plan. However, as they are now being requested routinely, ways to reduce the costs while allowing this new field of sub-seafloor observing to flourish need to be considered. SCIMPI systems offer a solution to this dilemma.

Installation procedures of the SCIMPI system are well-suited to a non-riser vessel or any open hole drilling method used by a mission specific platform. A SCIMPI system will not require the installation of a reentry cone or casing and can be installed in almost any IODP borehole after its total depth has been achieved. We estimate that it will take less than a day to deploy a few hundred meter long SCIMPI system after some operational experience has been gained. SCIMPI systems will be serviceable with a ROV or HOV, and a drill ship will never be needed for servicing. Thus, SCIMPI systems promise an enormous savings in drillship time and seafloor completion hardware.

Applications - Record numbers of proposals are being submitted that require CORKs to complete the science objectives. In one proposal, the SCIMPI concept was included (635-Full, Torres et al.).

Note that IODP Proposal 635 dubbed the concept “simCORK”, but its name was changed to SCIMPI to eliminate confusion with CORKs. The concept was reviewed positively by the SSEPs and will remain the central instrument in this proposal. In addition, the SCIMPI systems would be appropriate for most of the proposals where CORKs are proposed for sediment environments. Ultimately this concept could be expanded to include umbilical tubing to be run at the same time, which would enable OSMO samplers to be installed as part of a SCIMPI system.

The initial installation of a SCIMPI is being proposed to occur within a pilot hole to be drilled at site MBTS-3A associated with the Borehole Observatories in Monterey Bay. The drilling proposal outlined initial plans to use these holes to conduct various geohydrologic tests, including energetic pump tests and sustained pumping. The IODP panels have indicated enthusiasm for the MBTS for stimulating engineering initiatives that involve the development, testing, and implementation of new borehole technologies, especially the cable-connected boreholes and hole-to-hole experiments. The ultimate success of these sites will in part be based on the ability of future proponents to propose and conduct meaningful experiments at these particular sites.

There is a significant “Catch-22” situation developing. For the planned perturbation experiments in the geo-hydrologic hole at the Monterey Bay site to be properly conducted, some way of monitoring the subsurface changes needs to be in place. At present there is no plan to install a subsurface monitoring system during this expedition. However, deployment of a SCIMPI system would solve this “Catch-22” in a cost-effective manner.

The Monterey Bay Test Sites are a perfect place to install the prototype SCIMPI. This would provide a number of additional and timely benefits: (1) it would be a proof of concept for the SCIMPI system as an alternative to the traditional CORK; (2) because it is permanent, it would not have to be removed to conduct other experiments, yet it provides a built-in monitoring system for the test sites; (3) access to power and data transmission capability that the MARS cable will ultimately supply will fully demonstrate the feasibility of sub-seafloor perturbation experiments using a cable-connected system; and (4) the availability of ROVs at nominal cost to NSF-IODP or equivalent national agencies. Thus, we are keen to develop and deploy the first SCIMPI during the Monterey Bay IODP Expedition.

We are requesting 3 days of shiptime be added to the Monterey Bay program to accomplish this goal. This time estimate will allow 6 hours for the round trip with the drill pipe, 30 hours to drill a dedicated hole, and 1.5 days for the first SCIMPI deployment.