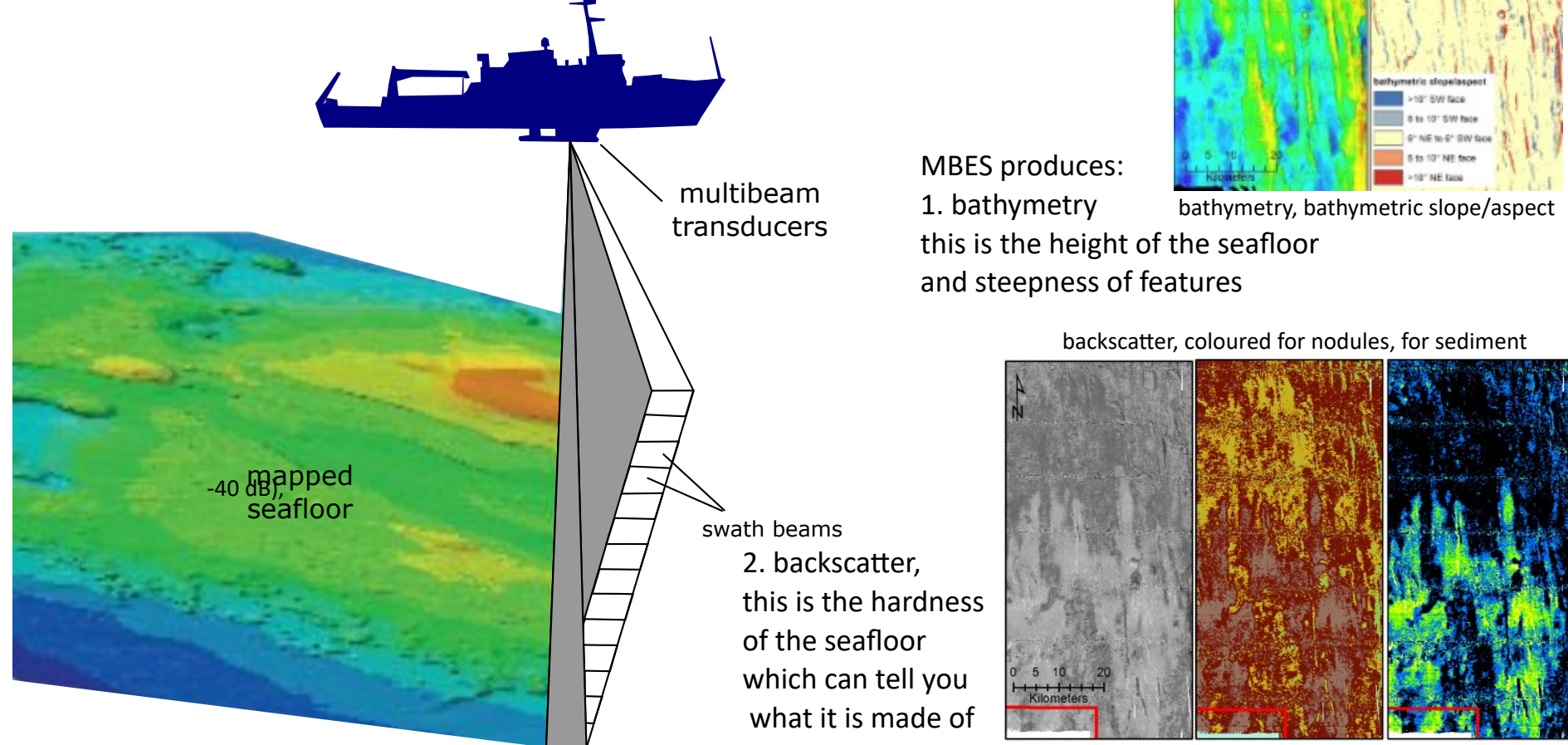


Exploration Techniques and Tools used for Geology and Mineral Resource Estimation

Multibeam echosounder

Multibeam echosounding (MBES) is the most effective way to get a detailed map of the seafloor. Fans of sound are sent to the seabed and their echos listened for. The resultant maps constrain the mineral resource model and help define habitats for environmental study.

MBES is often mounted on expedition boats, but can also be mounted on AUVs and ROVs.



Expedition boat

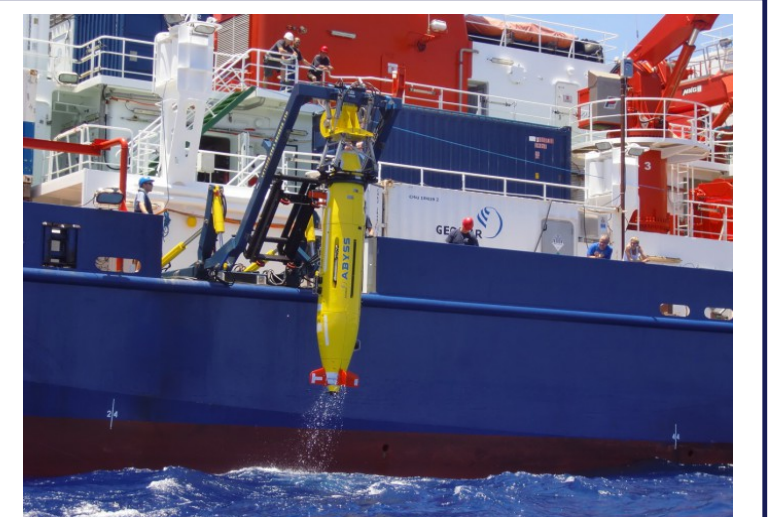
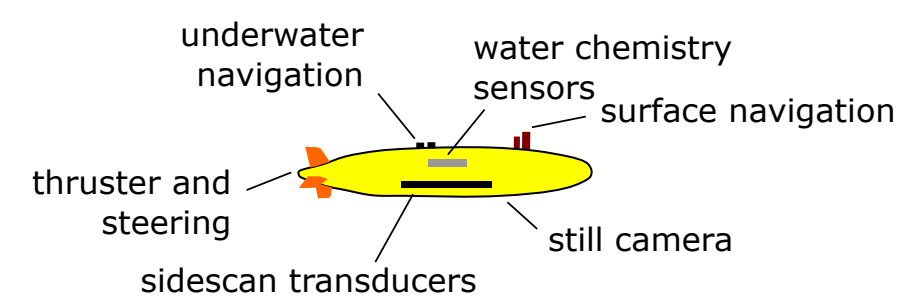
Expedition boats vary in size from <50 m long to >150 m long. They normally have more cabins than normal offshore work boats, and also have laboratories for geological and environmental sample processing and more elaborate computer and communications systems. Most expedition boats have large food storage and freezer space as well as large fuel and water tanks to support 2 month plus voyages.



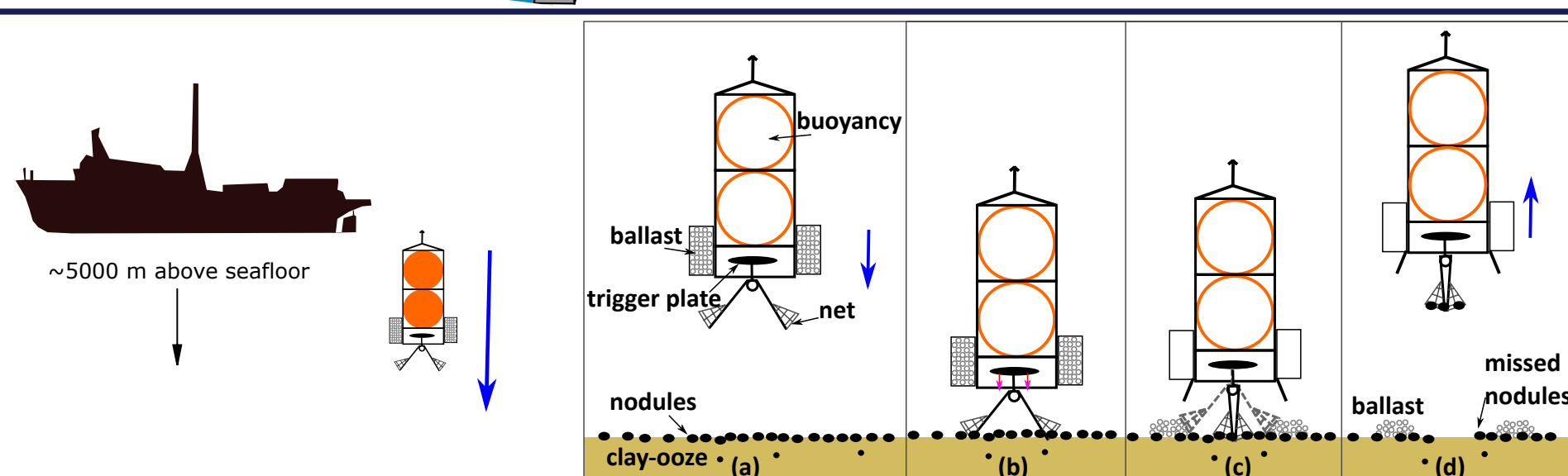
The R/V Yuzhmorgeologiya has completed over 100 expeditions in all corners of the world

AUV

Autonomous Underwater Vehicles (AUVs) are robot submarines. They use sophisticated navigation systems so that they can work independently of the expedition boat for significant periods of time. They usually contain a wide variety of sensors used for geological and environmental survey, but are limited by their batteries.



Geomar's Abyss AUV 'Tiffany' being recovered to the R/V Sonne



Free-fall grabs are used to collect seabed nodule samples. They have a major advantage in that they don't need to be lowered to the seafloor using a winch. They sink to the seabed, and release ballast as they collect a sample allowing them to return to the surface. This allows a smaller, less specialised boat to deploy and recover several of them at a time, usually several hundred metres apart..

There are several designs of free-fall grabs, but they all use the same principles.

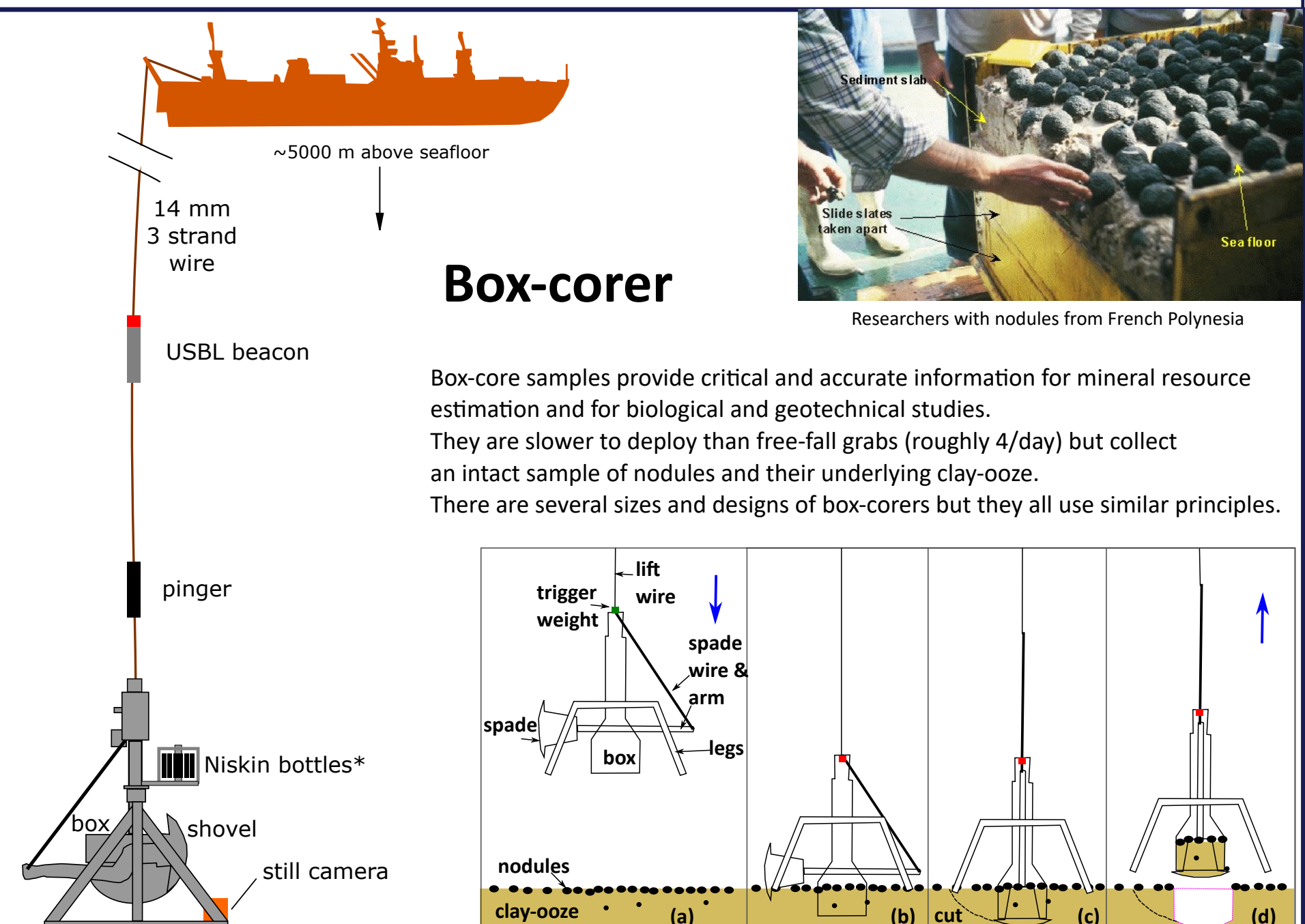


Free fall grab deployment in the Cook Islands by CIICSR Ltd.



< ~500 m >

Free-fall grabs

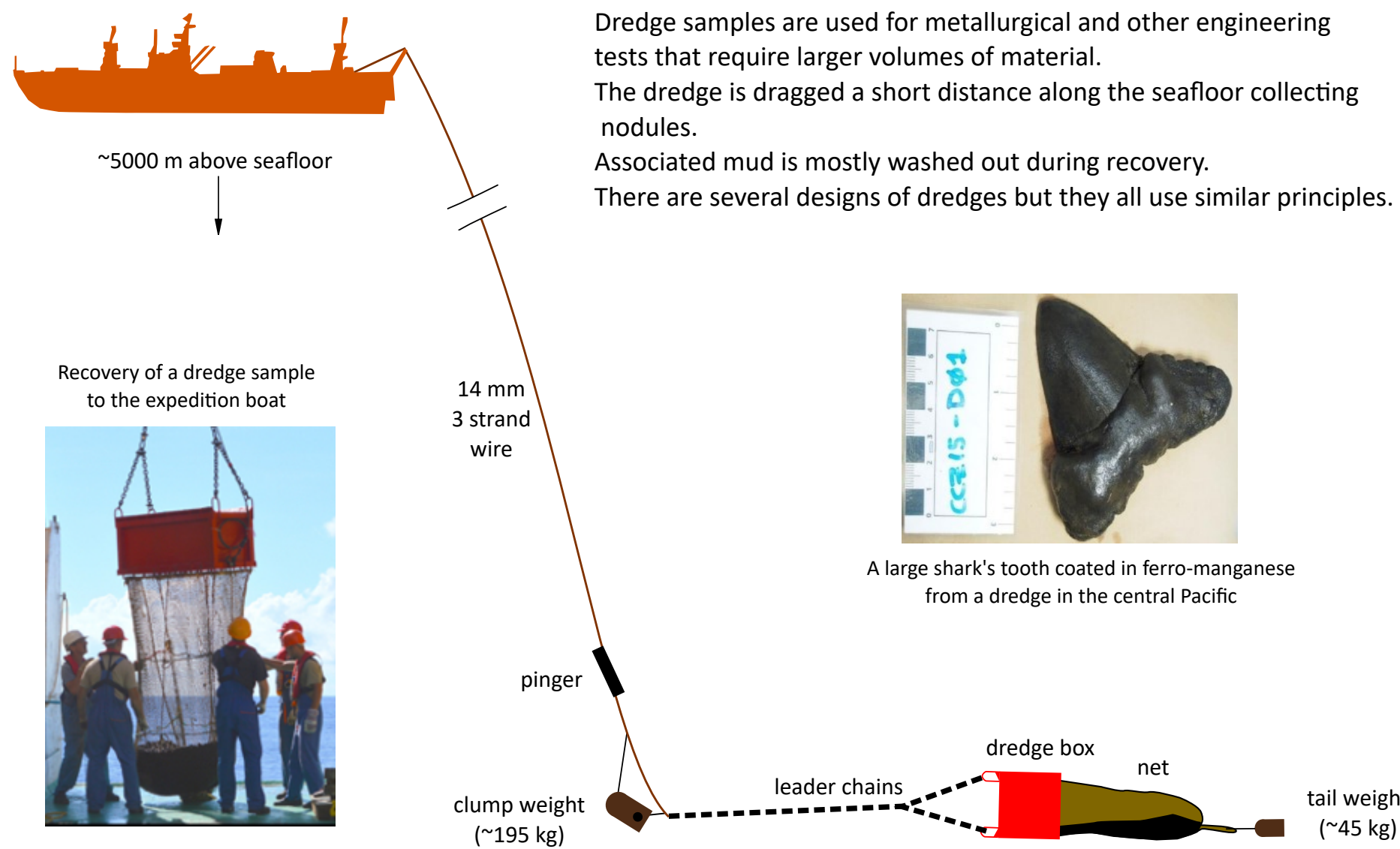


Researchers with nodules from French Polynesia

Box-corer

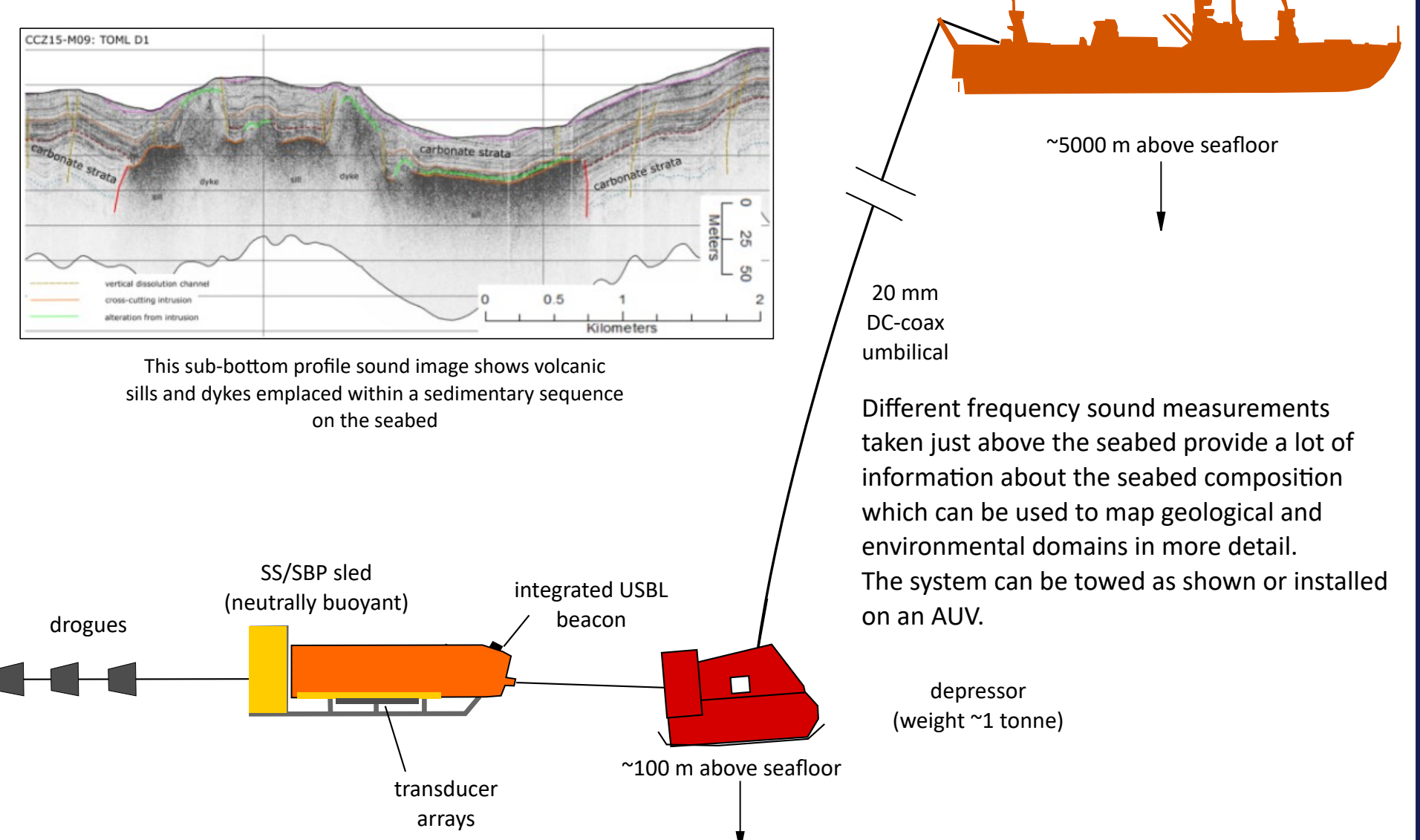
Box-core samples provide critical and accurate information for mineral resource estimation and for biological and geotechnical studies. They are slower to deploy than free-fall grabs (roughly 4/day) but collect an intact sample of nodules and their underlying clay-ooze. There are several sizes and designs of box-corers but they all use similar principles.

Dredge



Dredge samples are used for metallurgical and other engineering tests that require larger volumes of material. The dredge is dragged a short distance along the seafloor collecting nodules. Associated mud is mostly washed out during recovery. There are several designs of dredges but they all use similar principles.

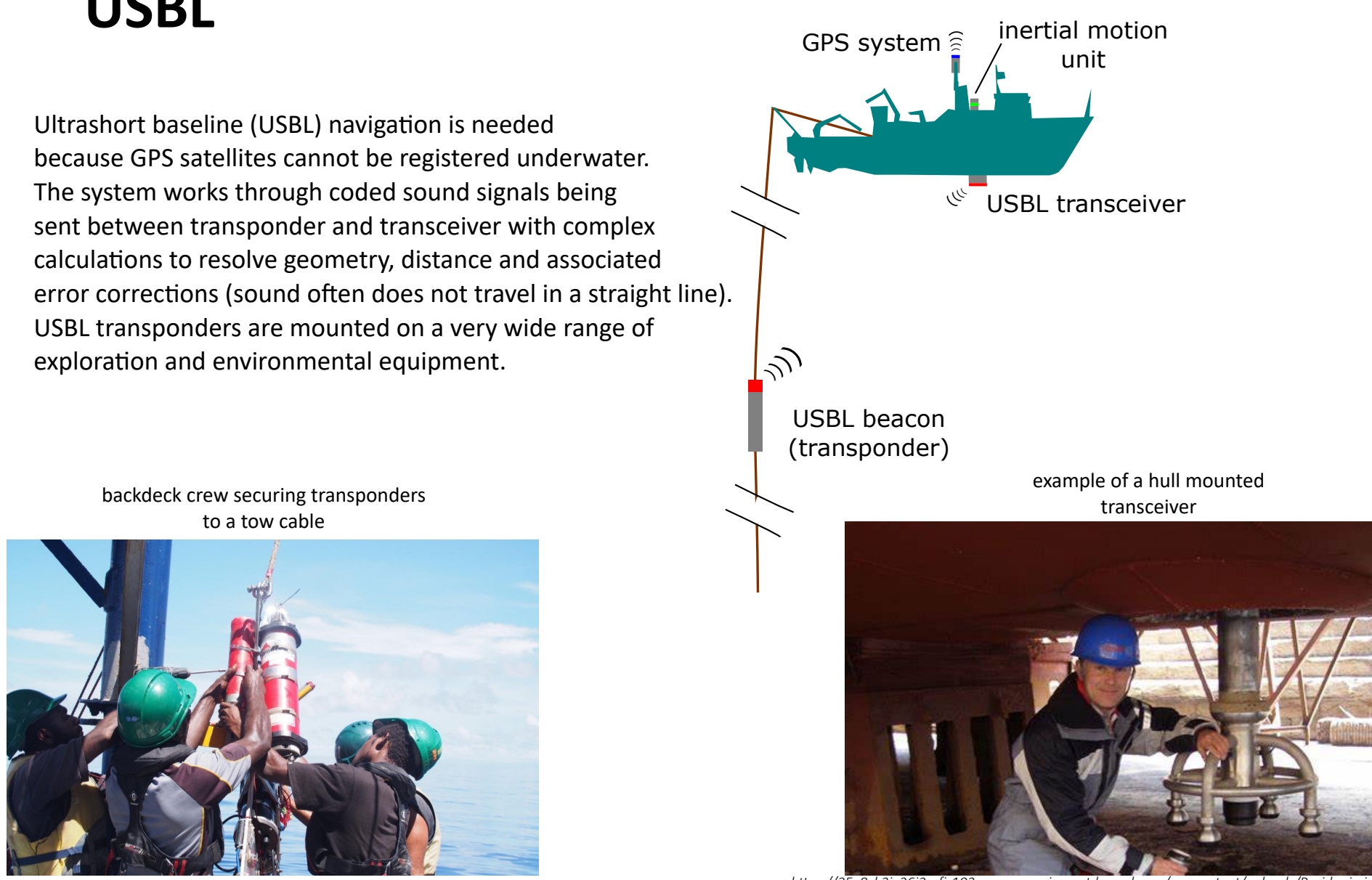
Sidescan and sub-bottom profiler



Different frequency sound measurements taken just above the seabed provide a lot of information about the seabed composition which can be used to map geological and environmental domains in more detail. The system can be towed as shown or installed on an AUV.

USBL

Ultrashort baseline (USBL) navigation is needed because GPS satellites cannot be registered underwater. The system works through coded sound signals being sent between transponder and transceiver with complex calculations to resolve geometry, distance and associated error corrections (sound often does not travel in a straight line). USBL transponders are mounted on a very wide range of exploration and environmental equipment.



Magnetometer

