SO258 Leg 1
INGON

Weekly Report No. 4
(26.06. – 02.07.2017)

R/V SONNE
2°59´S / 83°02´E

This week the geological studies of R/V SONNE cruise SO258 leg 1 focused on the Afanasy Nikitin Complex, which has been discovered as recently as in 1959 by the Russian research vessel VITIAZ. This submarine mountain consists of a ~400 km long and up to 140 km wide basal ridge, which rises from ~5,000 m below sea level (b.s.l.) to 2,000 m b.s.l. Several seamounts up to 2,000 m high and with a maximal base diameter of 25 km are located on the northern portion of this ridge. One of these seamounts has been named after the Russian explorer Afanasy Nikitin, who traveled in the 17th century amongst others to India, the Orient, and Africa. Until Friday we have carried out altogether 11 deep dredge hauls at fault scarps and the flanks of the basal ridge, of which nine recovered lava fragments and often also volcaniclastic rocks. Aphyric, olivine-phyric, olivine+feldspar-phyric, and with up to 50% plagioclase extreme feldspar-phyric varieties dominated among the lavas. Fortunately we frequently found unaltered volcanic glass in the dredges, which is particular suitable for geochemical analyses (see 3rd weekly report).

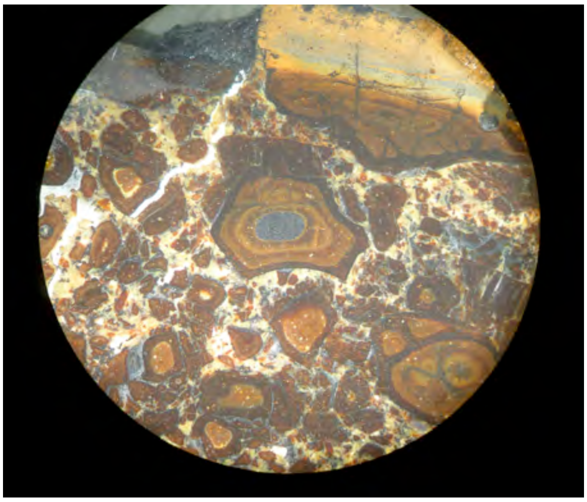
A dredge is emptied on deck after a successful haul. (photo: Nora Krebs)

Work on deck... (photo: Nina Furchheim)

On Saturday, July 10, we reached the area with the large seamounts in the northern section of the ridge. Afanasy Nikitin Seamount and a nearby seamount on the eastern flank of the ridge are so-called guyots. Guyots are seamounts that have steep sides and a relatively flat summit. They usually represent volcanoes that once formed ocean islands. After the volcanoes become extinct, the waves erode the islands to sea level, forming a flat top on the volcano. As the crust beneath the volcano cools, the guyots subside and the former wave cut top of the guyots drops beneath sea level. Notably the plateau margins of the two guyots are situated in different water depths (~1,700 m b.s.l. at Afanasy Nikitin and ~2,200 m at the seamount). It is unlikely that this difference is caused by tectonic processes because the seamounts are only 20 km apart. More likely is that the seamount on the eastern flank is older than Afanasy Nikitin Seamount, pointing to a complex, multi-phase magmatic evolution of the area. Unfortunately two dredge hauls at the guyot on the eastern flank yielded only semi-consolidated limestone. By contrast a dredge haul at a fault scarp at the base of the northern part of the ridge returned aphyric lava and volcaniclastic rocks which fortunately posses fresh glassy margins. Dredging at the Afanasy Nikitin Seamount was also successful. Here the dredge recovered vesicular olivine+feldspar-phyric lava with partly fresh glassy rims from a volcanic cone on its western flank.

A total of 28 dredge hauls has been conducted on this cruise up til now. Of these, 23 returned lava and 11 volcaniclastic rock. Only five dredges did not recover any hard rocks.

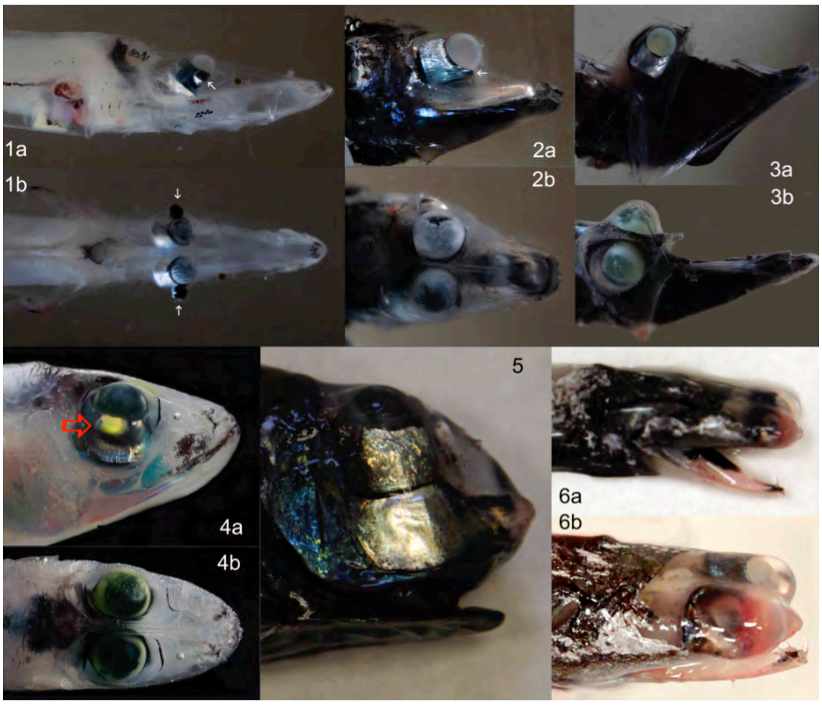
A young whale shark visits the SONNE. (Foto: Ulrich Mattheus)



This is not a newly discovered planet but a photomicrograph of a volcaniclastic rock. It consists of lava and glass fragments in a fine-grained, white groundmass. The ~5 mm long fragment in the center clearly shows that alteration (palagonitization) of the glass begun at its rim and proceeded in layers into the interior. Fresh glass is only preserved in the center of the fragment (grey area). (photo: Nina Furchheim)

The biologists carried out ten more trawls in the area of the Afanasy Nikitin Complex. In this area of complex seafloor topography there are upwelling currents that improve the supply of nutrients for the macrofauna and raise the chances for rich and interesting catches in our trawls. Indeed the most successful nets contained more than 500 fish, squid, and shrimp, with numerous large specimens, in very good condition, and sometimes alive. This allowed us to continue our pigment regeneration experiments, obtain additional data in the experiments on hearing in deep-sea fish and carry on the gene-expression studies for clock genes in fish from this special habitat. In addition the electrophysiological recordings to determine the spectral sensitivity of mesopelagic shrimp continued to produce consistent results. On Thursday and Saturday night three landers each were deployed for 12 h at the base and the top of the Afanasy Nikitin Seamount in order to study the effects of depth/pressure on the fish and amphipod communities.

For the perception of bioluminescence many animals living between 200 and 1,000 m water depth have developed a remarkable number of adaptions in order to boost visual sensitivity. On the molecular level, (1) this includes the matching of peak spectral absorbance to the visual pigment (rhodopsin) and the emission spectra of the photophores; on the microscopic level, (2) this leads to the maximizing of the photon catch area by enlarging the light sensitive membranes of photoreceptors (microvilli in squids and shrimp, and rod outer segments in fish); and on the macroscopic level (3) it entails the development of eyes with the largest possible pupil opening for maximal light collection. A special case in point is the occurrence of tubular eyes which may be thought of as central, cylindrical segments of the usual (half-) spherical eyes. Tubular eyes are found in both squids and fish (see figure on next page) as product of convergent evolution (see 3rd weekly report). Their advantage lies in the improved imaging of objects appearing as shadows against the downwelling residual sunlight. Their drawback, however, is the inability to see bioluminescence from below or from the side. Interestingly, several deep-sea fish with tubular eyes have found "tricks“ to overcome this obvious disadvantage: Some species like *Dolichopteryx, WInteria* und *Stylephorus* are capable of rotating their eyes by 90°, and thus enlarge their visual field if required. Other species, mainly from the family of barrel eyes (Opisthoproctids) have outpocketings („diverticula“) from the lateral wall of the tube eye which include special mirror optics that allow them to see bioluminescence from below (*Dolichopteryx*, for example). Other members of this family show still different variations of the general type of tubular eyes, and this cruise provides an opportunity for further investigations. Finally, some species like *Scopelarchus* have a lens-pad of highly refractive material at the sclero-corneal junction that might collect light form the side onto the lens and lead to an image on the retina. Here, too the material caught on this cruise will help to clarify the optical role of the lens pad and the resulting light pathways.



Fish with tubular eyes caught on this cruise in lateral (a) and dorsal (b) view; note the orientation of these eyes with respect to the main body axis. 1: *Dolichopteryx longipes* (Arrows indicate the large diverticulum that includes mirror optics); 2: *Winteria telescopa* (Arrow points at small diverticulum); 3: *Stylephorus chordatus*; 4. *Scopelarchus analis* (Open arrow indicates lens pad); 5. *Opisthoproctus soleatus*; 6. *Gigantura indica.* (Photo credits Figs. 1-4 Wensung Chun; 5-6 Ulrich Mattheus)

In the last week of this journey we will first finish the studies at the Afanasy Nikitin Complex and then conduct bathymetric surveys, dredging, and one more trawl in a to date largely unexplored area located ~300 nm to the southeast of Sri Lanka. The weather remained variable also this week with a mixture of clouds, sun, and partly heavy rain showers. Overall, we enjoy the warm tropical evenings with spectacular sun sets every now and then. All participants are well and send greetings from SONNE to everyone at home.

Reinhard Werner, Jochen Wagner, and the SO258/1 scientific party