

# Lucky Strike - A Potential MPA

## Location

Lucky Strike is the name of a field of hydrothermally active vents, situated southwest of the Azores in Portuguese waters on the Mid Atlantic Ridge ( $37^{\circ}18'N$ ,  $32^{\circ}16'W$ ).

## Potential Reasons for Selection

The Lucky Strike vent field has been chosen as one example amongst the four vent fields known to date in the North-East Atlantic. Due to its proximity to the Azores and its relatively shallow location, numerous scientific expeditions and programmes focus on the investigation of the temporal and spatial geological and biological variability. Given the small surface of the actual vent sites, a need for management of activities became particularly evident.

## Hydrothermal vents

Hydrothermal vents are geologically and biologically unique features on earth. Hydrothermal processes control the transfer of energy and matter from the interior of earth to its crust, hydrosphere and biosphere. They provide lessons to be learned with regard to their influence on ocean temperature, circulation patterns, chemistry and biology, the early genesis of earth and the possible development of life on earth. Hydrothermal vents occur in some but not all parts of the mid ocean ridges. Since their first discovery in 1977, a number of vent fields were found in all oceans. However, very little

is still known about most of the 50,000 km of ocean ridges. In these areas, the tectonic plates move apart, magma migrates in the subsurface and erupts at the seafloor. Due to the rock deformation, seawater penetrates to great depth and is rejected to the surface being enriched with large amounts of dissolved material, especially hydrogen sulfide ( $H_2S$ ), various sulfide minerals, metals, carbon dioxide ( $CO_2$ ) and methane. Depending

## Justification for the Potential Selection of the Lucky Strike Hydrothermal Vent Field as an Offshore Marine Protected Area

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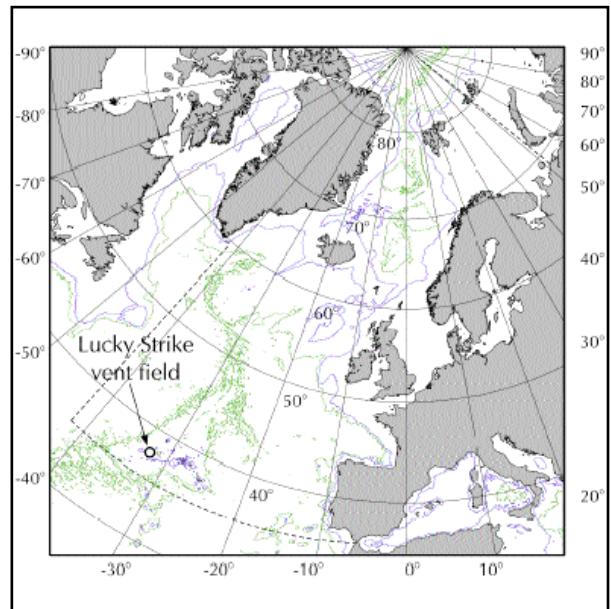


Fig. 1: The hydrothermal vent fields to the southwest of the Azores on the pressure of ejection and the ambient temperature, cristalization of the sulfide minerals forms chimneys known as „black“ or „white smokers“ for their colour. Variability in hydrothermal discharges from the short-term to decadal timescale causes temporal and spatial evolution of the animal communities associated with the vents, the lifetime of individual vents ranging from decades to about a century. Therefore, the composition of the vent-associated fauna is taxonomically similar, but not the same in all places.

Hydrothermal vents support some of the most unusual animal communities on earth. All deep sea animals have to cope with extremely high pressure. But contrary to the fauna of the surrounding uniformly cold, oxidized and sulfur-free deep sea waters, the vent associated organisms are adapted to locally very steep temperature gradients, transient extremes topping up to  $113^{\circ}C$ , low oxygen and potentially toxic concentrations of sulphur, heavy metals and radionuclides in the water. Similar to photoautotrophic plants on land, chemolithoautotrophic bacteria form the basis of the hydrothermal vent food web, using hydrogen sulfide to fuel the production of organic carbon. In the Pacific, the dominant vent fauna, e.g. the tube worm *Riftia pachyptila* and the clam *Calyptogena magnifica* derive their energy from endosymbiotic bacteria, while in the Atlantic, e.g. the shrimp *Rimicaris exoculata* appears to depend on ectosymbionts living in their digestive tracts. Surrounded by species-rich, low biomass deep sea benthos, hydrothermal vents locally constitute small, species-poor oases of very high productivity and biomass. However, recent findings suggest that for reproduction and larval dispersal, both systems may be linked by the seasonal input from the photic zone.

## Site Description

The Lucky Strike vent field was discovered in 1993. It is one of the largest hydrothermal areas known to date, with 21 active chimney sites distributed over an area of approximately 150,000 km<sup>2</sup> at around 1700 m depth. The chimneys are located around a fossile lava lake in the central caldeira of an axial volcano. The physical/chemical qualities of the vent gases and waters are distinct from other Mid Atlantic Ridge sites due to low sulphur/high methane contents. The maximum temperature of hydrothermal fluids reaches 333° C, which is close to boiling at these depths.



Fig. 2: A view on a densely populated mussel bed with associated shrimps taken from an underwater vehicle at Lucky Strike. Photograph by courtesy of D. Desbruyères.

## Biological Features of Lucky Strike

The faunal composition of the Lucky Strike vent field is considered sufficiently unique to make up a separate biogeographic hydrothermal province, the second on the Mid Atlantic Ridge. Depth, topography and/or the composition of the hydrothermal fluids are to be assumed as the key isolation mechanisms unless the existence of a biogeographic continuum is corroborated by research. Within the vent field, all sites are uniformly dominated by dense mussel beds (*Bathymodiolus azoricus*, up to 600 ind/m<sup>2</sup> or ca. 3.5 kg/m<sup>2</sup> biomass) which cover the surfaces of hydrothermally active sulfides and also occur in cracks in the sea floor where warm water emanates. Young mussels attached to older ones, and the length-frequency distribution at various micro-habitats point to sporadic reproduction forming age cohorts. The trigger is not known yet. The other dominant component of the Lucky Strike fauna is invisible: Nearly 95% of the mussels contain a blood-red commensal polychaete (*Branchipolynoe seepensis*) which has been recorded previously from other hosts/vent sites and also other sulphur-based food webs. A new species of bresiliid shrimp, *Charocaris fortunata* was found in moderate numbers among the mussels. Like other members of this genus, this shrimp is very light sensitive, having a special type of photoreceptive organ. In contrast to other Mid Atlantic Ridge sites, the Lucky Strike vent sites typically have an abrupt boundary coinciding with the limits of the mussel distribution and no peripheral fauna.

## Threats

The actual vent sites are of very limited size. Therefore, any frequent human activities will lead to disturbance. The lights of flashes and search lights, prerequisites to study the vents, may even damage the photosensitive deep sea fauna. The extensive research programmes going on at present involve a lot of geological and biological sampling which should be kept at a minimum. The genetic reservoirs and particular enzyme patterns of the specialized hydrothermal vent fauna is becoming increasingly attractive to bioprospection. This may cause additional sampling and habitat destruction. The metal contents of „smokers“ is high enough to make it a hot spot for commercial mining (so-called Sea-Floor Massive Sulphides SMS) even in view of the presently low market value of the minerals. Since active smokers are easiest to find, they will be the first target for exploitation, in particular if close-to-port and at moderate depth.

## Management Issues

A code of conduct is required for all research activities. This is pursued by the scientific community itself (Mullineaux et al. 1998): the frequency of visits to particular sites, as well as sampling and manipulation, should be reduced, „no-take“ vents should be designated and kept in their natural state to follow their evolution. Before granting licences of any industrial and touristic uses of the vents, Environmental Impact Assessments should be required and management plans established.

## Legal aspects

The Lucky Strike hydrothermal vent field is located in the Exclusive Economic Zone of Portugal, giving it the right to exploit its natural resources. However, Contracting Parties to the UN Convention on the Law of the Sea (UNCLOS) have the general obligation to „protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life“ (Article 194(5)). Furthermore, the Convention on Biological Diversity obliges Contracting Parties to conserve and sustainably use biodiversity by a.o. creating protected areas (Article 8(a)) as reflected by OSPAR Annex V.

## Action required

Lucky Strike hydrothermal vent field should be proposed as Marine Protected Area to OSPAR by Portugal. Management plans have to be developed and enforced.

Text prepared by Sabine Christiansen

## References/Further Reading

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