

ALKOR 290 Kiel – Kiel, 10.10. – 02. 11. 2006	
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## **Preliminary Report ALKOR 290**

# **Gas seeps in the central and northern North Sea**

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### **Objectives**

Cruise ALKOR 290 was part of the investigations of the collaborative project COMET (Controls on methane fluxes and their climatic relevance in marine gas hydrate-bearing environments) sponsored by the German Ministry of Education and Research and co-ordinated by IFM-GEOMAR. Objective of this cruise was to investigate how the benthic boundary layer methane turnover is regulated at shallow gassy sediments in comparison to gas hydrate bearing sediments at continental margins.

To address this question we surveyed the water column and seafloor in the vicinity of active gas flares and at pockmarks with hydro-acoustic methods, a manned submersible and TV-cameras mounted to a towed frame, respectively. Water samples for physical and chemical water properties as well as for methane were obtained from Rosette water sampler profiles. Gas flux from discrete gas flares was quantified with an oblique multi-beam system integrated into a bottom lander. Landers were only deployed for the duration of our working activities in the respective area. All sea floor investigation were operated under video control (sediment coring, lander deployments).

Work permissions were requested for the EEZs of the UK and Norway. Station work focussed on the Gullfaks and Tommeliten Oil/Gas Fields in Norwegian waters (Fig. 1) the later already studied by us in the previous year with RV ALKOR (ALKOR 259). In the UK waters we concentrated our activities to a former gas blow out south-east of the Fladen Ground which was also visited by us in 2005 during ALKOR expedition 259. A hurricane was forecasted during our activities at Tommeliten which forced us to abandon our research earlier than planned. We retreated into the Baltic Sea where we surveyed a pockmark field in the Eckernförde Bay (German EEZ).

## **Narrative**

### **Tuesday, 10-10-2006**

R/V ALKOR left the IFM-GEOMAR west shore pier at noon with 12 scientists on board. We steamed to the entrance area of Kiel Bay where we dropped anchor in the Strander Bucht to perform two test launches of the manned submersible JAGO. The second launch included a test dive of app. half an hour. The early evening was spent with compass compensation for JAGO. Shortly after 20:00h we left Kiel Fjord and started our journey to the Gullfaks Oilfield off Sogne Fjord (Norway) via the Kattegat and the Skagerrak.

### **Wednesday, 11-10-2006**

We continued our journey through the Kattegat and eastern Skagerrak in smooth weather conditions.

**Fig. 1:** Cruise track and stations of ALKOR Cruise 290

### **Thursday, 12-10-06**

We continued our passage to the Gullfaks area along the Norwegian coast through the Skagerrak and northern North Sea. Strong back winds (7-8Bft) favoured our travel.

### **Friday, 13-10-06**

We reached the Gullfaks Oilfield at 08:00h in the morning at 61°10.50'N, 002°14.85'E. We had already contacted the Oil Platform A manager in the previous evening and remained in constant contact with Platform A during our stay at Gullfaks.

A site map by courtesy of StatOil facilitated our station work significantly. In contrast to our journey when the wave direction and swell favoured our progress wave and winds made the ship roll considerably impeding our activities and preventing the launch of JAGO or the deployment of landers. We started station work with search profiles with the 38kHz echo sounder to image gas flares (Stat. 1476-77). In the afternoon we made a CTD/Ro cast (Stat. 1478) followed by an OFOS track crossing several gas flares of the so called "Heincke" Seep (Stat. 1479). In the evening and early night we mapped the deeper parts of the area (below 200m contour) with abundant small pockmarks with single beam and multi beam (180kHz) echo sounders (Stat. 1480). No gas flares were found in this survey. Station work was interrupted during the night.

### **Saturday, 14-10-06**

Station work started at 07:00h with a CTD/Ro cast (Stat 1481) followed by another gas flare imaging survey parallel to the slope contours crossing the Heincke Seeps

(Stat. 1482). Another CTD/Ro was taken afterwards (Stat. 1483). The BWS-Lander was prepared for a deployment at the "Heincke" Seep area during the afternoon. In the late afternoon we started the deployment with the star board A-Frame. The ship was still rolling considerably in the swell of about two metres. During the deployment the breaks of the winch failed caused by a movement of the ship adding extra weight to the 1.8t Lander. In consequence the lander smashed on the edge of working deck losing its anchor weight. The footings supporting the weight were damaged and the deployment had to be cancelled. Station work ceased during night.

### **Sunday, 15-10-06**

Station work started at 07:00h with another transect crossing the "Heincke" Seep to sample and measure methane content in the air above the gas flares (Stat. 1484). The BWS-Lander was restored during the course of the morning. Unfortunately we had no data- and video-transmission in the coaxial cable which prevented a video controlled deployment of the lander. The lander was therefore released at the sea surface and reached the sea floor in a free fall mode (Stat. 1485). The exact position was calculated from 3 different ship positions around the deployment site (triangulation) after acoustic distance measurements of the release transponders. The following scheduled JAGO deployment had to be cancelled since the rolling of the ship prevented a safe launch of the submersible. A series of van Veen grabs (Stat. 1486-91) was taken at the "Heincke" Seep followed by CTD/Ro casts (Stat. 1492-93). Station work was interrupted during the night.

### **Monday, 16-10-06**

Station work started at 08:00h with the preparation of the GasQuant Lander for a deployment at the Heincke seep. The preparations were finished at 11:00h when we had to interrupt the deployment procedure since a tanker approached crossing over our deployment course. The Lander was deployed successfully one hour in delay (Stat. 1494). The manned submersible JAGO was launched in the afternoon and performed a successful 3 hours-dive (Stat. 1495). In the evening we performed acoustic distance measurements of the release transponders of the GasQuant Lander to calculate the exact position from triangulation (Stat. 1496). This activity was followed by another multi-beam survey (Stat. 1597). Station works stopped during the night.

### **Tuesday, 17-10-06**

Station work started at 09:35h in the morning since we had to give way for a tanker. In the course of the morning we retrieved the BWS-Lander (Stat. 1498) and the GasQuant-Lander (Stat. 1499). A CTD/Ro followed these activities (Stat. 1500). A series of van Veen grab samples at the Heincke Flare was taken in the early afternoon (Stat. 1501-1505). We finished station work at Gullfaks at 14:00h and headed about 30nm south to take a CTD/Ro sample in waters outside the direct influence of gas flares (Stat. 1506). In the same area we drove some multi-beam profiles across a flat sea floor to calibrate the multi-beam system (Stat. 1507). Afterwards we started our passage to the next working area in the UK EEZ, the so called "Blow Out" in 57° 55.33'N; 01° 37.94' E a former oil/gas drilling blow out site which is still very active releasing a vigorous methane bubble stream reaching the sea surface. We visited this place already in 2005 on ALKOR expedition 259.

### **Wednesday, 18-10-06**

We reached the Blow Out site in the early afternoon and could confirm both by the spotting of surface bubbles and with the single beam echo sounder that the blow out was still active. Station work started with 3 OFOS transects crossing the blow out (Stat. 1508-10). We managed to drive the OFOS into the blow out crater and reached a depth 15m below the surrounding sea floor without reaching the bottom of the blow out. After that we drove with the rubber boat to the area of surfacing gas bubbles and took water samples (Stat. 1511). Station work ended this day with a CTD/Ro cast (Stat. 1512).

### **Thursday, 19-10-06**

Our investigations of the Blow Out site started in the morning with several transects across the suite to take air samples to measure possible gas exchange into atmosphere (Stat. 1513-1515). We finished our activities at the Blow Out site on that day with a CTD/Ro cast (Stat. 1516) and steamed about 50nm to the north-west where we mapped a pockmark field with the multi beam area in the Fladen Ground but could not find active gas flares. This survey (Stat. 1517) ended shortly before mid night.

### **Friday, 20-10-06**

We reached the Blow Out site again around 09:30h. A planned JAGO dive had to be cancelled since the large swell prevented a safe launch of the submersible. We prepared the BWS-Lander during the rest of the morning and deployed the system in about 50m distance from the gas crater (Stat. 1518). The afternoon was spent with a CTD/Ro cast (Stat. 1519) and another air sampling programme (Stat. 1521-23). More CTD/Ro casts followed until late evening (Stat 1524-28).

### **Saturday, 21-10-06**

Station work started at 08:30h with the launch of JAGO to dive into the blow out crater. This dive was successfully finished at 14:45h. The rest of the afternoon was spent to retrieve the BWS-Lander deployed the day before. In the course of the evening we steamed to the northwest in the region of the Fladen Ground pockmarks to search for gas flares at the so called ALKOR pockmark which we already surveyed the year before on ALKOR expedition 259.

### **Sunday, 22-10-06**

From 06:00h we drove several multi beam- and single beam transects (Stat. 1531) at the ALKOR pockmark to detect gas flares but could not find any. After a CTD/Ro cast (Stat. 1532) we decided to steam back to the Blow Out site where we drove a series of CTD/Ro casts during the afternoon until early evening (Stat. 1533-36). We spent the night at the Blow out site without further sampling activities.

### **Monday, 23-10-06**

Activities were focussed again on the Blow Out site. A second JAGO dive into the blow out depression was carried out during the morning and early afternoon (Stat. 1537). This was followed by six CTD/Ro casts until the evening (Stat. 1538-43) when we left the Blow Out site and headed towards the next station Tommeliten in the Norwegian EEZ in about 100nm distance.

**Tuesday, 24-10-06**

We reached Tommeliten at 56° 30.38´N, 002° 59.95´E at 07:00h and started research with a multi beam/single beam survey to identify gas flares (Stat. 1544-45). Several flares were located and the GasQuant-Lander (Stat. 1546) as well as the BWS-Lander (Stat. 1547) were deployed about 70m apart next to a prominent flare. Three CTD/Ro casts (Stat. 1548-50) followed until early evening, when station work was ceased until next morning.

**Wednesday, 25-10-06**

Station work started with a JAGO dive (Stat. 1551) in the vicinity of the previously deployed landers. We succeeded to take gas samples, sediment samples of a Beggiatoa mat (push corer) and retrieved a piece of authigenic carbonate. The retrieval of the two landers followed immediately (Stat. 1552-53). Since a hurricane was announced to hit the entire central and northern North Sea in the next day we had to abandon Tommeliten in the early afternoon. We steamed towards the Skagerrak thus finishing our surveying and sampling activities in the Norwegian EEZ.

**Thursday, 26-10-06**

We steamed in eastern direction through the central North Sea and Skagerrak several hours ahead to the hurricane front. We rounded Cape Skagen in the early afternoon. In the Kattegat we reduced our speed since we expected winds up to a maximum of BFT 10 from the south to south-west.

**Friday, 27-10-06**

We slowly progressed along the Danish coast. In the morning we were hit by the gale front and sought shelter under the coast off Grenaa. Winds reached BFT 9 - 10. Wind turned to west and dropped to BFT 7 - 8 in the early afternoon when we started our journey again through the southern Kattegat towards the Great Belt.

**Saturday, 28-10-06**

We reached our next station a pockmark field in the Eckernförde Bay (German EEZ, Baltic Sea) in the morning and started station work with a JAGO dive into a pockmark field (Stat. 1554). In the afternoon we deployed the GasQuant lander (Stat.1555). In the following we steamed to Eckernförde anchorage and took three scientists ashore with the rubber boat. We steamed back to our investigation area in the outer bay where we anchored until next morning.

**Sunday, 29-10-06**

Station work started again in the morning with another JAGO dive (Stat. 1556) which was followed by a CTD/Ro cast (Stat. 1557). In the afternoon we mapped the area of the pockmarks with the multi beam (Stat. 1558). Station work ended this day with the calibration of the GasQuant (Stat. 1559) by hanging a metallic sphere from the rubber boat in the beam area of the oblique multi beam of the GasQuant system. During the night the vessel rode anchor near the investigation area.

**Monday, 30-10-06**

We weighed anchor in the early morning and returned to Eckernförde to embark

one scientist via rubber boat. Station work started with the deployment of the Fluid Flux Observatory lander (FLUFO) in a pockmark ((Stat. 1560). In the afternoon we undertook another calibration of the GasQuant lander with the metal sphere (Stat. 1561) Station work was finished that day with the recovery of the GasQuant lander (Stat. 1562). During the rest of the day and the night we rode anchor next to the FLUFO mooring site to guard the system against trawling activities of local fishermen.

### **Tuesday, 31-10-06**

Station work started with an OFOS profile (Stat. 1563). In the early afternoon the FLUFO lander was recovered (Stat. 1564) and with this final activity station works of ALKOR 290 finished. At 14:25 we started our home journey to Kiel. We docked at the Schwentine Pier of the IFM-GEOMAR at 16:45h.

### **Wednesday, 01-11-06**

We unloaded the ship until afternoon thus ending ALKOR expedition 290.

### **Stationlist**

#### List of gear codes:

SBES/MBES: Single beam/multi beam echo-sounder

CTD/Ro: Conductivity-Temperature-Depth probe/Rosette water sampler

BWS-L: Bottom water sampler –Lander

GasQuant: Gas flux quantification (Lander)

FLUFO: Fluid flow observatory (Lander)

BG: van Veen grab

OFOS: Ocean floor observation system

JAGO: manned submersible “JAGO”

De: deployment

Re: recovery

**Station** **Gear** **No.** **Area** **Date** **Start** **Coordinates** **Depth** **at depth** **Coordinates** **Depth** **end**  
**stat.** **Coordinates** **No.** **2006** **Time** **Lat. N** **Long. E (m)** **Time** **Lat. N** **Long. E (m)** **Time** **Lat. N**  
1476 SBES/MBES 1 Gullfaks 13.10. 07:54 61°10,52' 002°14,85' 175 1477 SBES/MBES 2 Gullfaks 13.10. 10:30 61°13,31' 002°16,15' 226 1478 CTD/Ro 1 Gullfaks 13.10. 14:16 61°10,46' 002°14,47' 141 1479 OFOS 1 Gullfaks 13.10. 16:30 61°10,63' 002°14,88' 177 18:06 61°10,96' 002°15,75' 1480 SBES/MBES 3 Gullfaks 13.10. 19:47 61°12,02' 002°17,62' 221 1481 CTD/Ro 2 Gullfaks 14.10. 07:00 61°10,39' 002°14,61' 147 07:21 61°10,35' 002°14,84' 1482 SBES/MBES 4 Gullfaks 14.10. 09:45 61°10,90' 002°14,04' 171 12:54 61°10,93' 002°14,13' 1483 CTD/Ro 3 Gullfaks 14.10. 13:37 61°10,35' 002°14,53' 140 13:57 61°10,30' 002°14,94' 1484 SBES 5 Gullfaks 15.10. 06:54 61°10,41' 002°14,50' 166 09:10 61°10,35' 002°14,88' 1485 BWS-L /De 1 Gullfaks 15.10. 11:12 61°10,58' 002°14,52' 166 1486 BG 1 Gullfaks 15.10. 15:20 61°10,45' 002°14,67' 157 1487 BG 2 Gullfaks 15.10. 15:27 61°10,46' 002°14,66' 159 1488 BG 3 Gullfaks 15.10. 15:34 61°10,45' 002°14,64' 154 1489 BG 4 Gullfaks 15.10. 15:44 61°10,45' 002°14,63' 153 1490 BG 5 Gullfaks 15.10. 15:50 61°10,46' 002°14,62' 153 1491 BG 6 Gullfaks 15.10. 15:57 61°10,44' 002°14,63' 152 1492 CTD/Ro 4 Gullfaks 15.10. 16:19 61°10,45' 002°14,45' 140 17:02 61°10,46' 002°14,47' 1493 CTD/Ro 5 Gullfaks 15.10. 18:45 61°10,42' 002°14,47' 139 19:08 61°10,37' 002°14,89' 1494 GasQuant/De 1 Gullfaks 16.10. 12:35 61°10,43' 002°14,55' 148 1495 JAGO 1 Gullfaks 16.10. 14:05 61°10,37' 002°14,65' 147 17:16 61°10,37' 002°14,72' 1496 Vermessung Gullfaks 16.10. 19:31 20:00 1497 SBES/MBES 5 Gullfaks 16.10. 20:35 61°10,78' 002°14,73' 178 21:50 61°10,94' 002°15,57' 1498 BWS-L /Re 1 Gullfaks 17.10. 09:45 61°10,42' 002°14,02' 151 1499 GasQuant/Re 1 Gullfaks 17.10. 10:45 61°10,42' 002°14,02' 148 1500 CTD/Ro 6 Gullfaks 17.10. 11:13 61°10,37' 002°14,74' 149 11:30 61°10,34' 002°14,79' 1501 BG 7 Gullfaks 17.10. 12:46 61°10,39' 002°14,56' 143 1502 BG 8 Gullfaks 17.10. 13:04 61°10,46' 002°14,66' 158 1503 BG 9 Gullfaks 17.10. 13:16 61°10,41' 002°14,56' 146 1504 BG 10 Gullfaks 17.10. 13:23 61°10,40' 002°14,62' 147 1505 B G 11 Gullfaks 17.10. 13:30 61°10,45' 002°14,64' 154 1506 CTD/Ro 7 Reference 17.10. 16:16 60°49,99' 002°12,05' 124 16:26 60°50,00' 002°12,02' 1507 SBES/MBES 6 Reference 17.10. 17:03 60°50,00' 002°12,04' 124 18:55 60°48,95' 002°12,02' 1508 OFOS 2 Blow Out 18.10. 14:42 57°55,16' 001°37,97' 95 15:03 57°55,42' 001°37,64' 1509 OFOS 3 Blow Out 18.10. 15:10 57°55,34' 001°37,97' 95 15:31 57°55,17' 001°37,72' 1510 OFOS 4 Blow Out 18.10. 15:43 57°55,25' 001°37,93' 94 16:17 57°55,39' 001°37,73' 1511 water sample Blow Out 18.10. 16:28 57°55,34' 001°37,93' 95 17:12 57°55,33' 001°37,73' 1512 CTD/Ro 8 Blow Out 18.10. 18:33 57°55,30' 001°37,85' 95 18:42 57°55,33' 001°37,82' 1513 air profile Blow Out 19.10. 09:25 57°55,44' 001°37,76' 94 10:17 57°55,52' 001°37,76' 1514 air profile Blow Out 19.10. 10:40 57°55,97' 001°37,52' 93 11:40 57°55,61' 001°37,50' 1515 air profile Blow Out 19.10. 11:50 57°56,27' 001°37,76' 95 1516 CTD/Ro 9 Blow Out 19.10. 12:40 57°55,30' 001°37,80 93 12:53 57°55,29' 001°37,88' 1517 SBES/MBES 7 Fladen Gr. 19.10. 18:48 58°17,21' 0°24,78' W 127 23:50 58°17,30' 0°04,75' W 1518 BWS-L/De 2 Blow Out 20.10. 13:00 57°55,32' 001°37,85' 95 1519 CTD/Ro 10 Blow Out 20.10. 13:54 57°55,26' 001°38,00' 94 14:13 57°55,26' 001°37,94' 1520 CTD/Ro 11 Blow Out 20.10. 15:07 57°55,26' 001°37,91' 95 15:15 57°55,28' 001°37,94' 1521 air profile Blow Out 20.10. 16:18 57°55,19' 001°37,78' 96 16:36 57°55,39' 001°37,79' 1522 air profile Blow Out 20.10. 16:47 57°55,20' 001°37,72' 94 17:03 57°55,39' 001°37,73' 1523 air profile Blow Out 20.10. 17:15 57°55,20' 001°37,54' 97 17:29 57°55,40' 001°37,54' 1524 CTD/Ro 12 Blow Out 20.10. 19:22 57°55,35' 001°37,77' 95 19:46 57°55,39' 001°37,98' 1525 CTD/Ro 13 Blow Out 20.10. 20:55 57°55,34' 001°37,70' 94 21:05 1526 CTD/Ro 14 Blow Out 20.10. 21:15 57°55,29' 001°37,87' 98 21:28 1527 CTD/Ro 15 Blow Out 20.10. 21:35 57°55,29' 001°37,67' 98 21:35 1528 CTD/Ro 16 Blow Out 20.10. 21:48 57°55,13' 001°37,84' 95 21:58 1529 JAGO 2 Blow Out 21.10. 09:55 57°55,32' 001°37,69' 95 14:35 57°55,06' 001°38,05' 1530 BWS-L/Re 2 Blow Out 21.10. 16:34 57°55,30' 001°37,78' 95 1531 SBES/MBES 8 Fladen Gr. 22.10. 06:00 58°20,00' 000°58,35' 148 08:20 58°19,00' 000°55,04' 1532 CTD/Ro 17 Fladen Gr. 22.10. 08:58 58°19,15' 000°56,40' 149 09:08 1533 CTD/Ro 18 Blow Out 22.10. 13:45 57°55,17' 001°37,86' 97 13:55 57°55,15' 001°37,88' 1534 CTD/Ro 19 Blow Out 22.10. 15:14 57°58,19' 001°37,39' 97 15:23 57°58,10' 001°37,41' 1535 BG 12 Blow

Out 22.10. 16:05 57°55,30' 001°37,86' 98 16:41 57°55,25' 001°37,87' 1536 CTD/Ro 20 Blow  
 Out 22.10. 20:07 57°55,32' 001°37,86' 94 20:25 57°55,32' 001°37,86' 1537 JAGO 3 Blow  
 Out 23.10. 09:50 57°55,30' 001°37,70' 95 14:40 57°55,10' 001°37,10' 1538 CTD/Ro 21 Blow Out  
 23.10. 16:27 57°55,32' 001°37,97' 95 16:57 57°55,21' 001°37,79' 1539 CTD/Ro 22 Blow  
 Out 23.10. 19:05 57°59,30' 001°37,76' 95 19:16 57°55,29' 001°37,78' 1540 CTD/Ro 23 Blow  
 Out 23.10. 19:23 57°55,32' 001°37,84' 95 19:31 57°55,33' 001°37,83' 1541 CTD/Ro 24 Blow  
 Out 23.10. 19:41 57°55,30' 001°37,91' 94 19:51 57°55,30' 001°37,91' 1542 CTD/Ro 25 Blow  
 Out 23.10. 19:59 57°55,28' 001°37,85' 95 20:08 57°55,27' 001°37,85' 1543 CTD/Ro 26 Blow  
 Out 23.10. 20:20 57°55,87' 001°37,29' 95 20:25 57°55,  
 87' 001°37,29' 1544 SBES/MBES 9 Tommeliten 24.10. 07:01 56°30,38' 002°59,95' 73 09:55 56°29,24' 00  
 2°59,09' 1545 SBES/MBES 10 Tommeliten 24.10. 10:20 56°29,81' 002°59,68' 73 10:37 56°29,94' 002°59,7  
 4' 1546 GasQuant/De 2 Tommeliten 24.10. 12:24 56°29,92' 002°59,78' 73 1547 BWS-  
 L/De 3 Tommeliten 24.10. 14:43 56°29,87' 002°59,71' 73 1548 OFOS 5 Tommeliten 24.10. 15:53  
 56°29,88' 002°59,80' 74 16:11 56°29,99' 002°59,44' 1549 CTD/Ro 27 Tommeliten 24.10. 16:50 56°29,89' 0  
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 74 19:00 56°29,91' 002°59,72' 1551 JAGO 4 Tommeliten 25.10.  
 08:20 56°29,95' 002°59,65' 73 10:55 56°30,14' 003°00,09' 1552 GasQuant/Re 2 Tommeliten 25.10. 12:05 56°29,99'  
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 Bay 28.10. 09:30 54°29,06' 010°01,16' 24 12:50 54°29,06' 010°01,16' 1555 GasQuant/De 3 Eckernf.  
 Bay 28.10. 16:04 54°29,00' 010°01,24' 24 1556 JAGO 6 Eckernf.  
 Bay 29.10. 08:45 54°28,99' 010°01,32' 23 11:25 54°28,86' 010°01,42' 1557 CTD/Ro 27 Eckernf.  
 Bay 29.10. 12:51 54°28,99' 010°01,15' 25 12:57 1558 SBES/MBES 11 Eckernf.  
 Bay 29.10. 13:56 54°29,08' 010°01,22' 14:48 54°28,83' 010°00,88' 1559 calibration Eckernf.  
 Bay 29.10. 15:20 54°29,00' 010°01,24' 24 16:10 1560 FLUFO/De 1 Eckernf.  
 Bay 30.10. 11:00h 54°29,00' 010°01,17' 24 1561 calibration Eckernf.  
 Bay 30.10. 54°29,00' 010°01,24' 24 1562 GasQuant/Re 2 Eckernf.  
 Bay 30.10. 13:53 54°29,00' 010°01,26' 23 1563 OFOS 6 Eckernf.  
 Bay 31.10. 08:25 54°29,11' 010°03,88' 15 10:00 54°29,08' 010°01,81' 22 1564 FLUFO/Re 1 Eckernf.  
 Bay 31.10. 13:25 54°29,02' 010°01,27' 24

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