British Antarctic Survey Ships

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NATURAL ENVIRONMENT RESEARCH COUNCIL

The Antarctic continent is one of the most isolated places on Earth, surrounded by the world's roughest seas and protected by barriers of pack ice. To maintain its presence in Antarctica and to carry out its world-class scientific research programme, the British Antarctic Survey (BAS) operates two specially-designed ships.

RRS (Royal Research Ship) *James Clark Ross* and RRS *Ernest Shackleton* are ice-strengthened with powerful engines and sophisticated manoeuvring systems. As well as fulfilling a vital role in transporting passengers and cargo to and from the Antarctic, the ships also carry out ocean research work.

RRS *James Clark Ross* is primarily a marine science vessel for biological, oceanographic and geophysical cruises. RRS *Ernest Shackleton* works mainly as a logistics vessel, transporting cargo, fuel and people. Both meet the highest safety and technical specifications.

The ships are flagged in the Falkland Islands and their home port is Stanley. At the end of the Antarctic summer, the ships sail north to work in the North Sea and Arctic or undergo refits and repairs. In September or October they head south again with supplies and personnel for the next season's operations.

The Royal Navy ship HMS *Protector* also supports BAS science.

i The last continent

The first person to sight Antarctica from a ship is now widely accepted to be an Englishman, William Smith, who spotted the tip of the Antarctic Peninsula during a Royal Navy expedition in January 1820. However, during the same month, a Russian, Admiral Fabian Gottlieb von Bellingshausen, caught the first glimpse of the main Antarctic continent. The first person to land on Antarctica was probably the captain of an American whaling ship, John Davis, who went ashore in February 1821 at Hughes Bay on the Antarctic Peninsula.

Image: *RRS James Clark Ross (left) and RRS Ernest Shackleton.*

The worst seas in the world

The Antarctic is surrounded by the Southern Ocean – the confluence of the Indian, Atlantic and Pacific Oceans. Comprising more than 10% of the world's ocean, the waters around Antarctica are cold, stormy and covered with patches of ice.

Although the Southern Ocean is harsh and inhospitable to humans, it is rich with life and home to penguins, whales, seals and albatrosses. Beneath the waves the waters harbour an abundance of fish, squid and krill. The Southern Ocean also plays a key role in global climate. The Antarctic Circumpolar Current, that isolates the frozen continent, is the most powerful ocean current system on the planet.

The BAS ships that operate in Antarctic waters have to be able to cope with the fiercest storms, high winds and the largest waves on Earth. With waves sometimes exceeding 10 metres in height, it's no wonder sailors refer to these latitudes as the 'Roaring 40s,' 'Furious 50s,' and 'Screaming 60s'. For those travelling to Antarctica by sea, particularly those unaccustomed to life onboard ship, this can make the journey extremely uncomfortable.

One of the greatest hazards for ships is ice. In winter, sea ice is frozen around the Antarctic coast. In places, this floats away from land in massive sheets called pack ice. There are also icebergs to contend with – huge lumps of ice that have calved away from the ice shelves and glaciers surrounding the continent.

In the past, many ships have become trapped in the pack ice. Most famously, in 1915, the legendary explorer Ernest Shackleton's ship, *Endurance*, was crushed by the ice. Although his expedition failed and his ship was lost, in a remarkable undertaking, he managed to bring all his men to safety.

Breaking the ice

Both BAS ships are ice-strengthened and designed to 'plough' through most of the ice they encounter. Navigating through pack ice requires specialist skill and training. Often it involves carving the easiest path but sometimes it amounts to sheer brute force. Here is a description of the process from the ship's diary of RRS James Clark Ross: "Suddenly the bow contacts the edge of the solid ice and the air is full of bangs, crashes, scratching, screaming, tearing, scraping and cracking. The floor shakes, moves and vibrates with each crack and the whole ship is rocked from side to side."

Image: *RRS Ernest Shackleton in a force 12 storm.*

Logistics

BAS operates four research stations in and around Antarctica as well as managing an additional research station on South Georgia. During the Antarctic summer there can be more than 250 scientists and support personnel stationed around the continent. Everything they need to survive and work needs to be imported by air or sea. Those 50 or so who remain in Antarctica during the winter need adequate supplies for over six months of isolation.

The BAS ships are a lifeline to the UK's presence in Antarctica. They supply the stations with food, drink, equipment and infrastructure. With the exception of sewage and food, they also remove all waste generated by BAS operations. If a new building is to be constructed, the ships will supply the materials. Any demolition and the ships will take away the debris.

Onboard ship

Most people working for BAS travel to Antarctica via the Falkland Islands or Punta Arenas, Chile. They will then either fly to their final destination or travel by ship. The largest British research station in Antarctica, Rothera, has a gravel runway which can accommodate BAS's four-engined Dash 7 aircraft. Others will travel to and from Antarctica by sea, particularly those stationed at Halley, which is built on a floating ice shelf and almost exclusively supplied by ship.

For many, this will be their first time onboard ship and apart from the, often violent, movement of the vessel there are new customs to get acquainted with. As well as learning all the important safety procedures, staff are expected to help with cleaning, cooking and cargo handling. However, both ships do have a gym, sauna, DVDs and a bar.

From the diary of RRS *Ernest Shackleton*

"It's amazing the varieties of jobs that go on during the daily routine of life onboard. The five [BAS scientists] are not spared as they get enlisted to assist in repairs, painting, putting up smoke extractors in the common room and mechanical jobs down below decks in the Engine Workshop. The meteorologists are getting their introduction to making daily observations on the bridge and our Cadets are also getting some good training from the Deck Officers as time and operations permit."

Image: *Careful packing of the hold onboard RRS Ernest Shackleton.*

Science

Both RRS *James Clark Ross* and RRS *Ernest Shackleton* are equipped as floating laboratories. Because they can operate in the harshest of conditions, they are perfectly suited to studying the oceans surrounding the Earth's polar regions.

Research cruises seek to tackle a diverse range of scientific questions including the impacts of climate change, the effects of change on marine organisms, the impacts of fishing and the geological history of the planet. The ships have 'wet' and 'dry' laboratories and specialist sampling equipment as well as winches and cranes to lower experiments into the sea.

Case study – biology and bongos

There is a long history of over-exploitation of Antarctic marine life. In the 19th century this meant whaling. In the 21st century the main problem is over-fishing. Managing these natural resources requires scientific knowledge that can only be obtained by detailed studies of the food web. This involves examining the whole ecosystem from the smallest bacteria right through to the largest predator.

One of the key components of the food web is right at the bottom. It's been estimated that copepods – fingernail sized crustaceans – make up the greatest mass of any many-celled organism in the world's oceans. Their stocks have a major effect on higher animals. To study them, BAS scientists lower special nets known as 'bongo nets' over the sides of the ship. These nets are dropped to 400m then brought back up catching all the crustaceans above them. Species are then identified and counted to give an indication of the number in the water. This information can then be used to help understand and assess the health of the Antarctic ecosystem.

Image: *Lowering bongo nets over the side of RRS James Clark Ross.*

RRS *James Clark Ross* is one of the most sophisticated marine research vessels afloat. Built by Swan Hunter Shipbuilders at Wallsend on the River Tyne, it was launched by the Queen in December 1990.

The ship is powered by diesel engines which drive an electric propulsion system. In open waters the vessel can travel at a steady 12 knots for more than 50 days at sea. In pack ice of up to one metre thick, the engines can drive the ship at a constant two knots.

To help break through heavy pack ice, the ship is also equipped with a special compressed air system which forces water from one side of the ship to the other causing the ship to roll. This rolling prevents the pressure of the ice from squeezing and damaging the hull.

The ice-strengthened hull, the propulsion and other ship's systems are designed for extremely quiet operations. They prevent background noise from interfering with the performance of sensitive underwater research equipment. Bow and stern thrusters combined with a joystick control system allow for extremely precise manoeuvring and positioning for scientific work.

Who was James Clark Ross?

Admiral Sir James Clark Ross (1800-1862) is one of Britain's most successful early polar explorers. He discovered the North Magnetic Pole in 1831 before going on to make three voyages to Antarctica. In 1841 he discovered a 'barrier' of ice, later to be renamed the Ross Ice Shelf. In the same year he was amazed to discover an active volcano, which he called Mount Erebus after one of his ships. The volcano was later to provide a backdrop to Scott's and Shackleton's expeditions to Antarctica.

Image: *RRS James Clark Ross in heavy sea ice.*

Science on RRS *James Clark Ross*

With well equipped laboratories, computer suites, cranes and winches, the ship is ideally suited to its scientific role. Its equipment includes a compressor bank to power a large seismic air gun array; this is used to 'fire' sound waves into the seabed. The echo that is reflected off the rock and back to the ship is picked up by underwater microphones called hydrophones. The information is then processed by computers to determine the undersea geology.

The sediments of the Southern Ocean contain a record of the past and provide scientists with information on the history of ice coverage in the area. These can be vital for understanding past climate patterns and predicting future global climate change. The midships gantry of RRS *James Clark Ross* is used to lower eight tonne corers, capable of obtaining 30 metre-deep sediment cores from the sea bed.

To obtain biological samples, from the smallest plankton to the largest fish, the vessel is able to deploy a wide range of sampling equipment, including trawl nets, to investigate stocks of commercial species of fish. Winches are used to lower equipment or tow nets behind the ship and the 25 metre-long afterdeck gives plenty of space for operating equipment or for housing small containerised laboratories. For oceanographic research, the chemical, physical and biological characteristics of the surface sea water can be monitored continuously by electronic sensors.

Inside, there are 'wet' laboratories to study live biological samples or messy sediments. There are also 'dry' laboratories, specialised areas for chemical or physical analysis, and a central scientific control room.

From the diary of RRS *James Clark Ross*

"The first objective for the week was to map the bathymetry [depth] of the sea floor, using SWATH (a term used for echo sounding a 'swath' of ground on the seabed). We're 'pinging' 191 little 'pingers' every 20 seconds. These send pulses out that bounce back from the sea floor to the ship, like an echo. The length of time it takes them to do this tells us the distance to the seafloor and maps the topography… Traditionally, swath surveys are conducted in horrible weather. The words "it's for the sake of science" are uttered often through gritted teeth as all onboard batten everything down for yet another lumpy day!"

Image: *Deployment of the benthic sledge from RRS James Clark Ross on a snowy morning in Marguerite Bay, Antarctica.*

RRS *James Clark Ross* factfile

Ship type	Lloyds +100A1 ICE CLASS IAS + LMS UMS (Research/Survey/Cargo)
Year built:	1990
Length overall:	99.04 metres
Breadth:	18.85 metres
Loaded displacement:	7,767 tonnes
Deadweight:	2,887 tonnes
Gross tonnage:	5,732 tonnes
Speed:	12 knots
Endurance:	57 days
Scientific facilities:	6 laboratories plus workshops and control areas
Accommodation:	20 cabins (1, 2 and 4 berth)
Cargo:	1,500m^3 general cargo
Propulsion:	Diesel Electric, single fixed propeller, 8,500SHP (shaft horse power) Bow thruster, controllable 360°, 10 tonnes thrust Stern thruster, controllable 360°, 4 tonnes thrust
Personnel:	The maximum number of personnel onboard is limited to 80 (27 Officers/Crew, 1 Doctor and 52 Expedition Personnel)

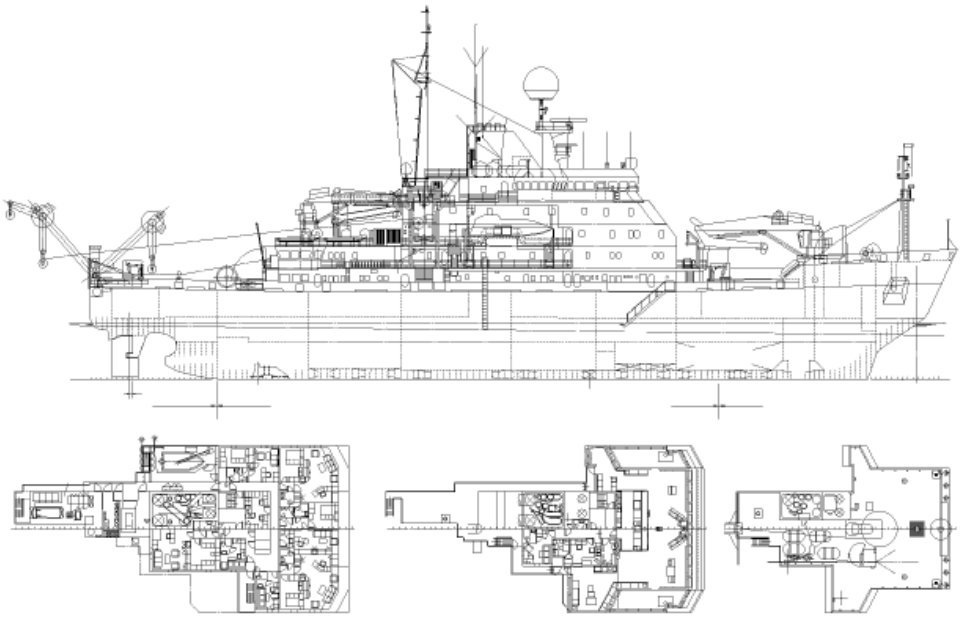


Image: *Part of the original plans for RRS James Clark Ross.*

RRS *Ernest Shackleton* was built in Norway in 1995 for the Norwegian company, Rieber Shipping of Bergen. Originally named MV *Polar Queen*, it was acquired by BAS in August 1999, renamed and re-registered in the Falkland Islands.

As a versatile support and research vessel RRS *Ernest Shackleton* is ideally suited for operation in polar waters. The ice-strengthened ship's primary role is a wide range of logistics tasks, providing support to BAS operations. However, the ship also has a scientific capability and on most voyages a small research team works onboard. Science facilities include 'dry' and 'wet' laboratories, cranes, and surveying and oceanographic equipment.

When used for Antarctic work, the ship sails from the UK to South America or directly to the Falkland Islands. However, she is also deployed in the northern hemisphere for up to 120 days per year, working in a support and survey role.

Designed to cruise at 12 knots in open water, RRS *Ernest Shackleton* is equipped with two powerful diesel engines as well as a sophisticated manoeuvring system. The ship also has a helicopter deck. It is the only BAS ship used to supply the isolated Antarctic station at Halley every year.

Who was Ernest Shackleton?

RRS Ernest Shackleton is named after the famous polar explorer. Sir Ernest Shackleton (1874-1922) first travelled to Antarctica on the British 'Discovery' expedition of 1902. He went south again in 1908 when he came within 97 nautical miles of the South Pole. But he is best remembered for his failed attempt to cross the continent in 1915. After a winter trapped in the pack ice, his ship, Endurance, was eventually crushed. The men's epic journey from the Weddell Sea to South Georgia remains one of the greatest-ever tales of survival under the most extreme circumstances.

Image: *RRS Ernest Shackleton anchored to the sea ice.*

A lifeline to Antarctica

Transporting cargo, people, food and supplies to Antarctica is a major logistical undertaking which starts many months before the ships sail. By the end of August most cargo needs to be ready for loading and careful records are kept to ensure everything is packed correctly and reaches its correct destination. An oversight at this stage and an important piece of equipment could remain in the UK, on the other side of the world from the scientist that needs it.

As well as BAS equipment and supplies, personal possessions also need to be shipped south. With some people remaining in Antarctica for up to two-and-a-half years, what to take and what to leave behind requires a good deal of thought. RRS *Ernest Shackleton* is usually loaded at Immingham in October and it can take up to 10 long days before the holds are full and the ship is ready for the journey south.

From the UK to the Falkland Islands takes 27 days passage. On arrival, it's a further six days sailing to Rothera and almost two weeks to Halley. Unloading at Rothera is relatively straightforward as the station has a wharf. At Halley there's only ice, so a suitable natural dock has to be found before the cargo can be unloaded onto sledges and hauled in 'trains' by snowmobiles across the ice shelf.

The only year that thick pack ice prevented the ship from making it to Halley was in 2002. A decision was taken to anchor the ship in comparative safety over 300 kilometres away and 'ferry' passengers and essential supplies using four BAS Twin Otter aircraft.

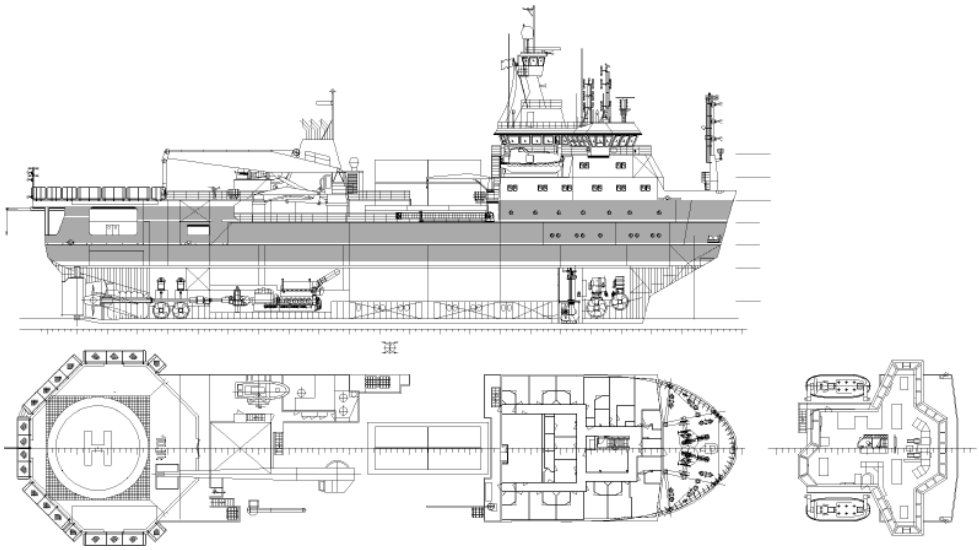
From the diary of the RRS *Ernest Shackleton*

"The fair Shackleton went to sea and straight out into a gale force 8 in the English Channel. For those new joiners who had never experienced the 'Polar Roller' before, it was a bit of an awakening. Not that many of them have been 'awake' since leaving land on Thursday… As we turned the corner into the Bay of Biscay, there was a slight relief from the pitching. She started to roll instead. Either way, the mass of papers strewn all over the office floors and the cabins pays testimony to the motion of the ocean and we are all hoping for an improvement in the next days, so we can walk the alleyways without bouncing off the walls like so many pinball machine balls."

Image: *RRS Ernest Shackleton during relief of Halley Station.*

RRS *Ernest Shackleton* factfile

Ship type	DnV +1A1 ICEBREAKER ICE 05 EO HELIDK ICS DYNPOS-AUTR W1 (Research/Survey/Cargo)
Year built:	1995
Length overall:	80 metres
Breadth:	17 metres
Loaded displacement:	5,455 tonnes
Deadweight:	1,910 tonnes
Gross tonnage:	4,028 tonnes
Speed:	12 knots in open water
Endurance:	130 days
Scientific facilities:	Dry lab, wet lab, craneage for package deployment
Accommodation:	37 cabins (1, 2, 3 and 4 berth)
Cargo:	3,000m^3 general cargo
Heli-Deck:	Maximum Helio weight 10 tonnes Maximum Helio rotor diameter 20 metres
Propulsion:	2 x Diesel Main Engines, 7,200SHP (shaft horse power), driving variable pitch propeller in nozzle 360° retractable azimuth thruster, 1,100SPH 1 x tunnel thruster, 1,100SPH 3 x tunnel thrusters, 800SHP
Personnel:	The maximum number of personnel onboard is limited to 72 (22 Officers/Crew and 50 Expedition Personnel)



For more information on BAS ships including full technical specification, itineraries and diaries of life onboard ship, please visit the BAS website:

www.antarctica.ac.uk

Image: *Part of the original plans for RRS Ernest Shackleton.*

British Antarctic Survey (BAS), a component of the Natural Environment Research Council, delivers and enables world-leading interdisciplinary research in the Polar Regions. Its skilled science and support staff based in Cambridge, Antarctica and the Arctic, work together to deliver research that uses the Polar Regions to advance our understanding of Earth as a sustainable planet. Through its extensive logistic capability and know-how BAS facilitates access for the British and international science community to the UK polar research operation. Numerous national and international collaborations, combined with an excellent infrastructure help sustain a world-leading position for the UK in Antarctic affairs.

www.antarctica.ac.uk

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