

= Pine Island Glacier =

Pine Island Glacier (PIG) is a large ice stream glacier , and the fastest melting glacier in Antarctica , responsible for about 25 % of Antarctica 's ice loss . The glacier ice streams flow west @-@ northwest along the south side of the Hudson Mountains into Pine Island Bay , Amundsen Sea , Antarctica . It was mapped by the United States Geological Survey (USGS) from surveys and United States Navy (USN) air photos , 1960 ? 66 , and named by the Advisory Committee on Antarctic Names (US @-@ ACAN) in association with Pine Island Bay .

The area drained by Pine Island Glacier comprises about 10 percent of the West Antarctic Ice Sheet . Satellite measurements have shown that the Pine Island Glacier Basin has a greater net contribution of ice to the sea than any other ice drainage basin in the world and this has increased due to recent acceleration of the ice stream .

The ice stream is extremely remote , with the nearest continually occupied research station at Rothera , nearly 1 @, @ 300 km (810 mi) away . The area is not claimed by any nations and the Antarctic Treaty prohibits any new claims while it is in force .

= = Ice sheet drainage = =

The Antarctic ice sheet is the largest mass of ice on earth , containing a volume of water equivalent to 57 m (187 ft) of global sea level . The ice sheet forms from snow which falls onto the continent and compacts under its own weight . The ice then moves under its own weight toward the edges of the continent . Most of this transport to the sea is by ice streams (faster moving channels of ice surrounded by slower moving ice walls) and outlet glaciers . The Antarctic ice sheet consists of the large , relatively stable , East Antarctic Ice Sheet and a smaller , less stable , West Antarctic Ice Sheet . The West Antarctic Ice Sheet is drained into the sea by several large ice streams , most of which flow into either the Ross Ice Shelf , or the Filchner @-@ Ronne Ice Shelf . Pine Island and Thwaites Glaciers are two major West Antarctic ice streams which do not flow into a large ice shelf . They are part of an area called the Amundsen Sea Embayment . A total area of 175 @, @ 000 km² (68 @, @ 000 sq mi) , 10 percent of the West Antarctic Ice Sheet , drains out to the sea via Pine Island Glacier , this area is known as the Pine Island Glacier drainage basin .

= = Weak underbelly of the West Antarctic Ice Sheet = =

The Pine Island and Thwaites glaciers are two of Antarctica 's five largest ice streams . Scientists have found that the flow of these ice streams has accelerated in recent years , and suggested that if they were to melt , global sea levels would rise by 1 to 2 m (3 ft 3 in to 6 ft 7 in) , destabilising the entire West Antarctic Ice Sheet and perhaps sections of the East Antarctic Ice Sheet .

In 1981 Terry Hughes proposed that the region around Pine Island Bay may be a " weak underbelly " of the West Antarctic Ice Sheet . This is based on the fact that , unlike the majority of the large West Antarctic ice streams , those flowing into the Amundsen Sea are not protected from the ocean by large floating ice shelves . Also , although the surface of the glacier is above sea level , the base lies below sea level and slopes downward inland , this suggests that there is no geological barrier to stop a retreat of the ice once it has started .

= = Acceleration and thinning = =

The speed of Pine Island Glacier increased by 73 percent from 1974 to the end of 2007 , with an 8 percent increase over the last 16 months of this period alone . This speed up has meant that by the end of 2007 the Pine Island Glacier system had a negative mass balance of 46 gigatonnes per year , which is equivalent to 0 @. @ 13 mm (0 @. @ 0051 in) per year global sea level rise . In other words , much more water was being put into the sea by PIG than was being replaced by snowfall . Measurements along the centre of the ice stream by GPS demonstrated that this acceleration is still high nearly 200 km (120 mi) inland , at around 4 percent over 2007 . It has been suggested that

this recent acceleration could have been triggered by warm ocean waters at the end of PIG , where it has a floating section (ice shelf) approximately 50 km (31 mi) long . It has also been shown that PIG underwent rapid thinning during the Holocene , and that this process may continue for centuries after it is initiated .

As the ice stream accelerates it is also getting steeper . The rate of thinning within the central trunk has quadrupled from 1995 to 2006 . If the current rate of acceleration were to continue the main trunk of the glacier could be afloat within 100 years .

= = Subglacial volcano = =

In January 2008 the British Antarctic Survey (BAS) scientists , Hugh Corr and David Vaughan , reported that 2 @, @ 200 years ago a volcano erupted under the Antarctic ice sheet . This was the biggest Antarctic eruption in the last 10 @, @ 000 years . The volcano is situated in the Hudson Mountains , close to Pine Island Glacier . The eruption spread a layer of volcanic ash (or tephra) over the surface of the ice sheet . This ash was then buried under the snow and ice . Corr and Vaughan were able to map this ash layer using an airborne radar system and calculate the date of the eruption from the depth of burial of the ash . This method uses dates calculated from nearby ice cores . The presence of the volcano raises the possibility that volcanic activity could have contributed , or may contribute in the future , to increases in the flow of the glacier .

= = History of fieldwork = =

= = = On the ice = = =

Due to the remoteness of Pine Island Glacier , most of the information available on the ice stream comes from airborne or satellite @-@ based measurements .

The first expedition to visit the ice stream was a United States over @-@ snow traverse , where they spent around a week in the area of PIG during January 1961 . They dug snow pits to measure snow accumulation and carried out seismic surveys to measure ice thickness . One of the scientists on this traverse was Charles R. Bentley , who claims " we didn 't know we were crossing a glacier at the time . " This is not surprising , because PIG is around 50 km (31 mi) wide at the point visited and at ground level cannot be visually distinguished from the surrounding ice . This expedition was called the Ellsworth Highland Traverse .

Then in the 2004 / 2005 field season a team of 9 using a British Antarctic Survey (BAS) Twin Otter aircraft , equipped with ice penetrating radar , completed an aerial survey of PIG and its adjacent ice sheet . The team of 7 British & 2 Americans led by Dave Vaughan & Hugh Corr flew 30 km grid patterns over the PIG until mid @-@ January 5 , mapping the sub @-@ glacial terrain of that area roughly equal to the size of the State of Nevada .

Due to the remoteness of PIG and the logistical difficulties of caching enough fuel for the 04 / 05 expedition and future project (s) , BAS used the resources of the United States Antarctic Program (USAP) and their ski @-@ equipped LC130 aircraft .

After many weeks of weather delays the first four men (Ben Partan , Rob Smith , Dave Anderson & Martin Bell) arrived from McMurdo on 11 / 9 / 04 and began to establish camp and build a skiway for the C130 ? s . Camp was established on the upper end of the ice stream at S77.76973 x W095.12713. The remaining members of the team arrived from Rothera approximately 10 days later in the Twin Otter , flown by survey pilot Dave Leatherdale .

Because of unusually good weather in the area that season the survey completed flying their grids early (mid @-@ January) and began flying 15 km grids of Thwaites Glacier for a USAP expedition who had been experiencing unusually poor weather in their area that year . Flying over Antarctica ? s Pine Island Glacier in a DC @-@ 8 research plane , scientists participating in NASA ? s IceBridge mission made a startling discovery on October 14 , 2011 : a massive crack running about 29 kilometers (18 mi) across the glacier ? s floating tongue . The rift is 80 metres (260 feet) wide on

average and 50 to 60 meters (160 to 200 ft) deep , and it marks the moment of creation for a new iceberg that will span about 880 square kilometers (340 square miles) once it breaks loose from the glacier .

All survey grids having been completed by the end of January , the survey crew flew back to Rothera leaving the two Americans and two British to dismantle the camp . A week later the remaining team members flew back to McMurdo leaving a fuel cache for future expeditions .

Another team from the British Antarctic Survey arrived at the ice stream on 8 December 2006 for the first of two field seasons . In the second field season , they spent three months there from November 2007 to February 2008 . Work on the glacier included radar measurements and seismic surveys .

In January 2008 Bob Bindschadler (NASA) landed on the floating ice shelf of PIG , this is at the downstream end where it floats on the sea . This landing , by a Twin Otter plane fitted with skis , was the first ever landing on this ice shelf . The reason for landing on the ice shelf was for a reconnaissance mission to investigate the feasibility of drilling through around 500 m (1 @, @ 600 ft) of ice , to lower instruments into the ocean cavity below . It is hoped that this will provide important information on the link between the ocean and Pine Island Glacier . It was decided that the small crevasse free area was too hard for further landings and so further fieldwork had to be postponed . Therefore , two GPS units and a weather station were positioned as near as possible to PIG .

Since then , the National Science Foundation has decided to establish a helicopter camp for the scientists to safely study the ice @-@ ocean interaction . During the 2010 ? 11 summer field season in Antarctica , it is planned that tractors and sleds will haul all of the equipment needed to establish a camp near the ice shelf . A tractor train traverse of about 700 km (430 mi) is needed to deliver the materials . The plan over the following two field seasons , 2011 ? 12 and 2012 ? 13 , is for scientists to use helicopters to fly to sites on the ice shelf , where they will deploy specially designed profilers down through the ice shelf to measure various ocean properties .

2011 @-@ 2012 field season : after five weeks of delays , the camp staff was finally able to establish the Main Camp just before New Years . The following week Dr Bindschadler and his team were able to arrive . Due to additional weather delays , the helicopters weren 't able to arrive by the NSF ' drop dead ' date and the field season was essentially cancelled . Fortunately limited science was still accomplished by the team thanks to a series of flights by KBA back onto the glacier ; it seems that conditions had changed drastically since the last twin otter flights .

The British Antarctic Survey deployed a small team of four (Dr Andrew Smith , Gabriel Chevailler , Ashly Fusiarski , Ian Hey) during the 2011 @-@ 12 summer field season to carry out a series of seismic and radar surveys on PIG . They also installed a series of overwintering GPS stations . During this same field season , a separate BAS team (Dr Mark Clilverd , Tom Stroud) was inputted to the field parties location and they installed an overwintering autonomous VLF station . This was followed by a radar traverse upstream using skidoos . This survey linked previous radar lines .

= = = From the sea = = =

The first ship to reach Pine Island Glacier 's ice shelf , in Pine Island Bay , was the USS / USCGC Glacier in 1985 . This ship was an icebreaker operated by the U.S. Coast Guard . The mission , known as Deep Freeze , had scientists on board who took sediment samples from the ocean floor .

During the summer field season , over two months from January to February 2009 , researchers aboard the U.S. Antarctic Program research vessel Nathaniel B. Palmer reached the ice shelf . This was the second time that the Palmer had successfully made it up to the glacier , the first time being in 1994 . In collaboration with the British , the scientists used a robotic submarine to explore the glacier @-@ carved channels on the continental shelf as well as the cavity below the ice shelf and glacier . The submarine , known as Autosub 3 , was developed and built at the National Oceanography Centre in the UK . It completed six successful missions , travelling a total of 500 km (310 mi) under the ice shelf . Autosub is able to map the base of the ice shelf as well as the ocean floor and take various measurements and samples of the water on the way . The success of Autosub 3 was particularly notable because its predecessor Autosub 2 was lost beneath the Fimbul

Ice Shelf on only its second such mission .