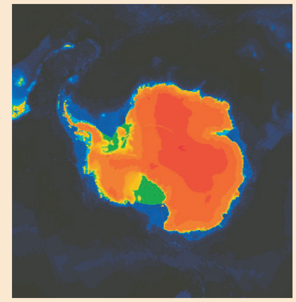
CTDI

Coiled Tubing Drill for Ice
An Exploration Tool for Polar Sciences



The CTDI drilling system uses a high-pressure pump and 'coiled tubing' to deliver fluid to a steerable downhole hydraulic motor that drives a cutting bit.

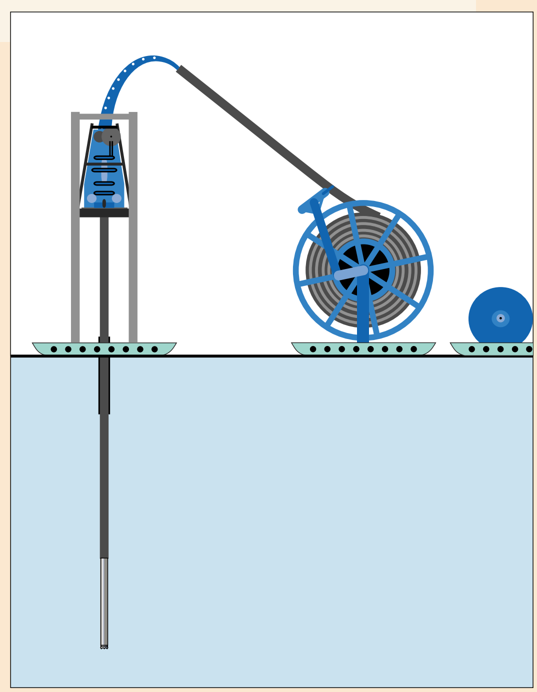
Applications

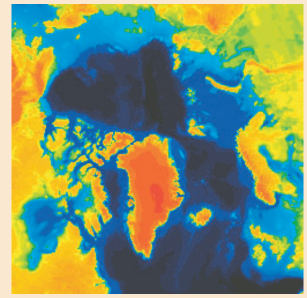
- Rapid access to deep ice and subglacial environments
- Produce arrays of semi-permanent deep access holes for a variety of investigations (climatological, geological, glaciological, biological)
- Deep ice-core site selection
- Subglacial rock coring and "targeted" ice coring
- Directional drilling to obtain additional ice or rock samples from previously drilled boreholes
- Access hole instrumentation can provide a wide range of in-situ data, including: temperature, dust and microbe concentrations, dielectric properties (DEP), sonic velocity, stress/strain, video and others

Capabilities

- LC-130 transportable
- Sled-mounted for easy mobilization
- Modular design for fast setup

Total weight	**26,000 kg**
Number of sleds	**5**
Crew size	**3**





Capabilities - cont.

- Rock & Ice Drilling:
  - maximum depth — 3-4 km
  - hole diameter — 7-13 cm
  - effective drilling rate, ice — 40 m/hr
  - effective drilling rate, rock — 10-40 m/hr
  - time to drill a 3-4 km hole in ice: — 6-8 days
    (including setup time & downtime)
- Rock & Ice Coring:
  - coring rate, ice — 8 m/hr
  - coring rate, rock — 3 m/hr
  - core length, ice — 3 - 6 m
  - core length, rock — 3, 6, 9 m
- Trip Rates:
  - downhole — 30 m/min
  - uphole — 40 m/min
  - time to acquire 3-m rock core at 3 km — 4 hrs
- Fully Steerable:
  - allows "directional" or "sidetrack" drilling
  - can drill multiple sidetracks
  - horizontal drilling out to 900 m from main wellbore
  - inclined drilling to 110°
- Variety of Drilling Fluids Can be Used:
  - non-freezing (e.g. n-butyl acetate)
  - hot water
  - air

Capabilities - cont.

- Fluid Treatments can be Injected at Specific Depths Downhole:
  - glycol or hot-water to free a stuck drill
  - hydrogen peroxide to sterilize downhole instrumentation
  - polymerizing gel to seal a wellbore
- Can Install Instrument Packages, Packers, or Cryobots, at Depth
- Optional Downhole Tools:
  - wall “polisher” for measurements requiring a very smooth wellbore
  - continuous sidewall sampler for isotopic analyses
  - sonic transponder to determine exact distance to a lake
- Enhanced Safety:
  - Several attributes make the CTDI safer to setup and operate than other deep drilling systems.

FAQs

- What’s the difference between the CTDI and a traditional hot-water drill?

The primary difference is that the CTDI drills mechanically rather than using heat to melt ice. This allows the CTDI to remain relatively compact and portable and still achieve great depths. In addition, the CTDI deposits much less heat into the surrounding ice than a HWD, is specifically designed to drill rock as well as ice, and is fully steerable.

- Can the CTDI be used to obtain continuous ice core?

No. The CTDI is designed for rapid access to great depth and the acquisition of short “targeted” cores. Continuous ice core from the surface of an ice sheet to its bed is still best obtained with a traditional ice coring drill. The CTDI and ice coring drills have complementary capabilities. The speed and portability of the CTDI would allow it to be used as an exploratory drill, testing various characteristics of proposed ice core sites before committing a deep ice-core drill to a specific location.

FAQs - cont.

- What's the status of the CTDI drilling system?

The Coiled Tubing Drill for Ice (CTDI) is still at the "concept" stage; detailed engineering analysis and design work have not yet been done. However, the oil & gas industry has done a great deal of research and development on coil tubing drills (CTDs). A wide variety of CTDs are now commercially available. These drills are much more compact, offer a higher degree of safety and control, require much smaller crews, and are cheaper to operate that traditional drills. The largest market for CTDs is arctic Alaska and Canada. These drills have become so operationally efficient that 70% of all oil-drilling in northern Alaska is now done with CTDs. The proposed CTDI drilling system would build on this experience. Nearly all the components are commercially available.

For More Information:

- See

"A Fast Mechanical-Access Drill for Polar Glaciology, Paleoclimatology, Geology, Tectonics, and Biology" by G.D. Clow and B. Koci, Proceedings of the International Workshop on Ice Drilling Technology, Ice Drilling Technology 2000.

- or Contact

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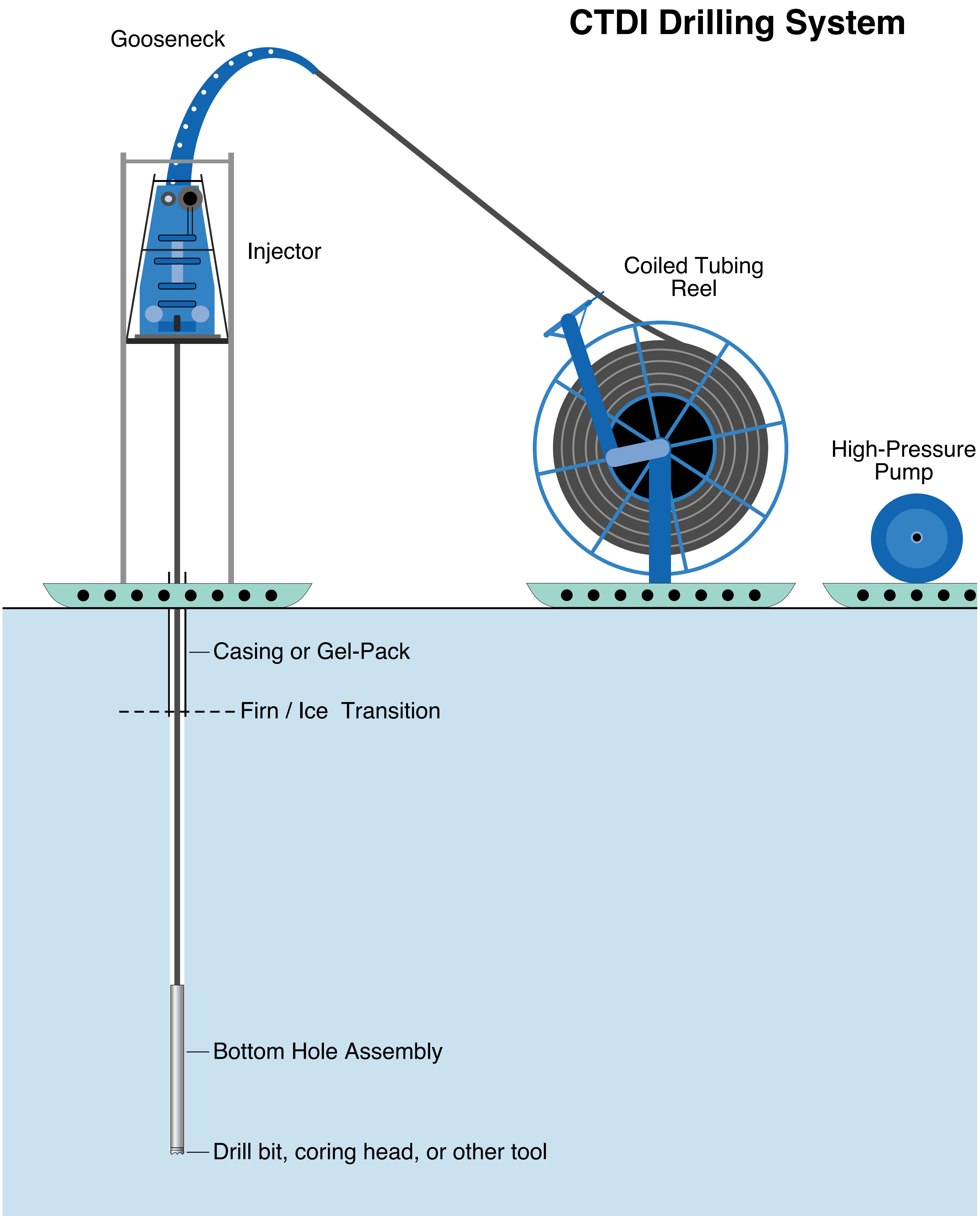
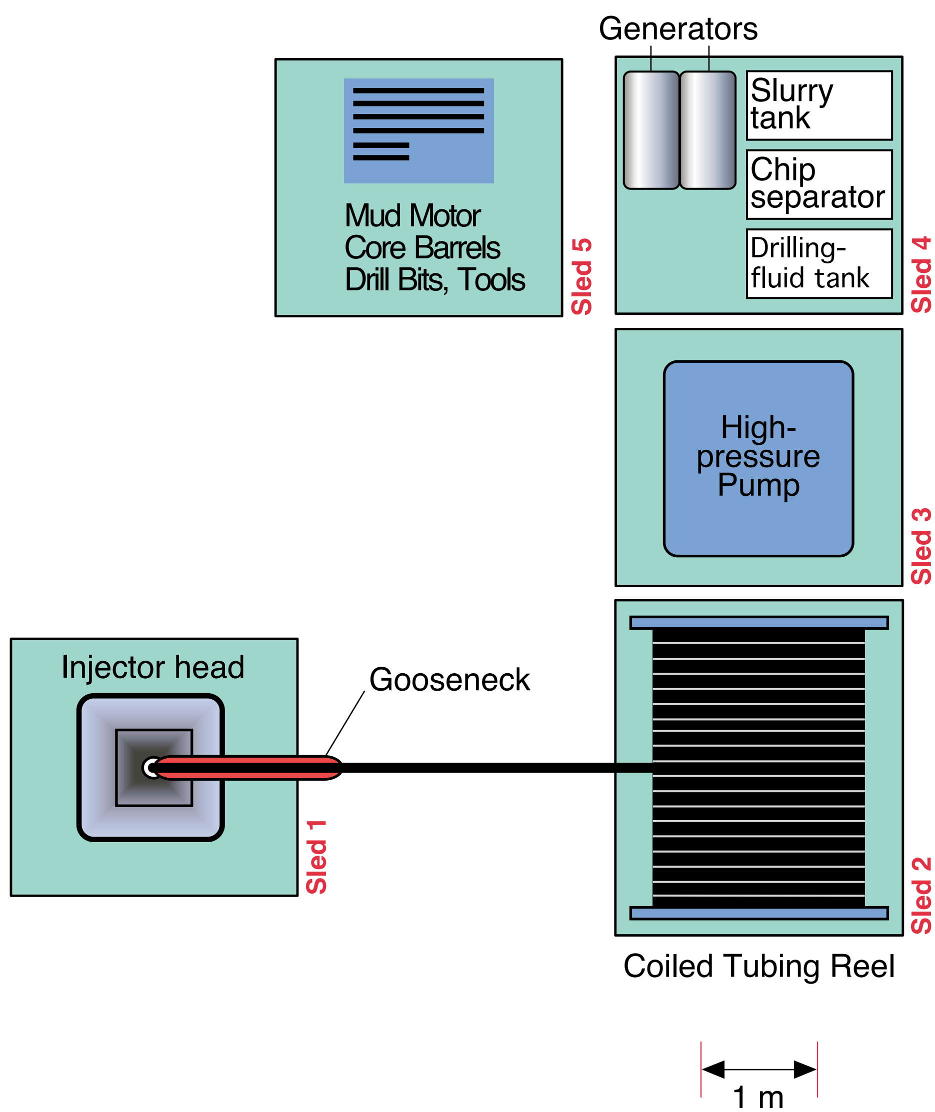
* The numbers presented in this document are our best estimates at this time. They are based on published reports and numerous discussions with people who use commercial CTDs.

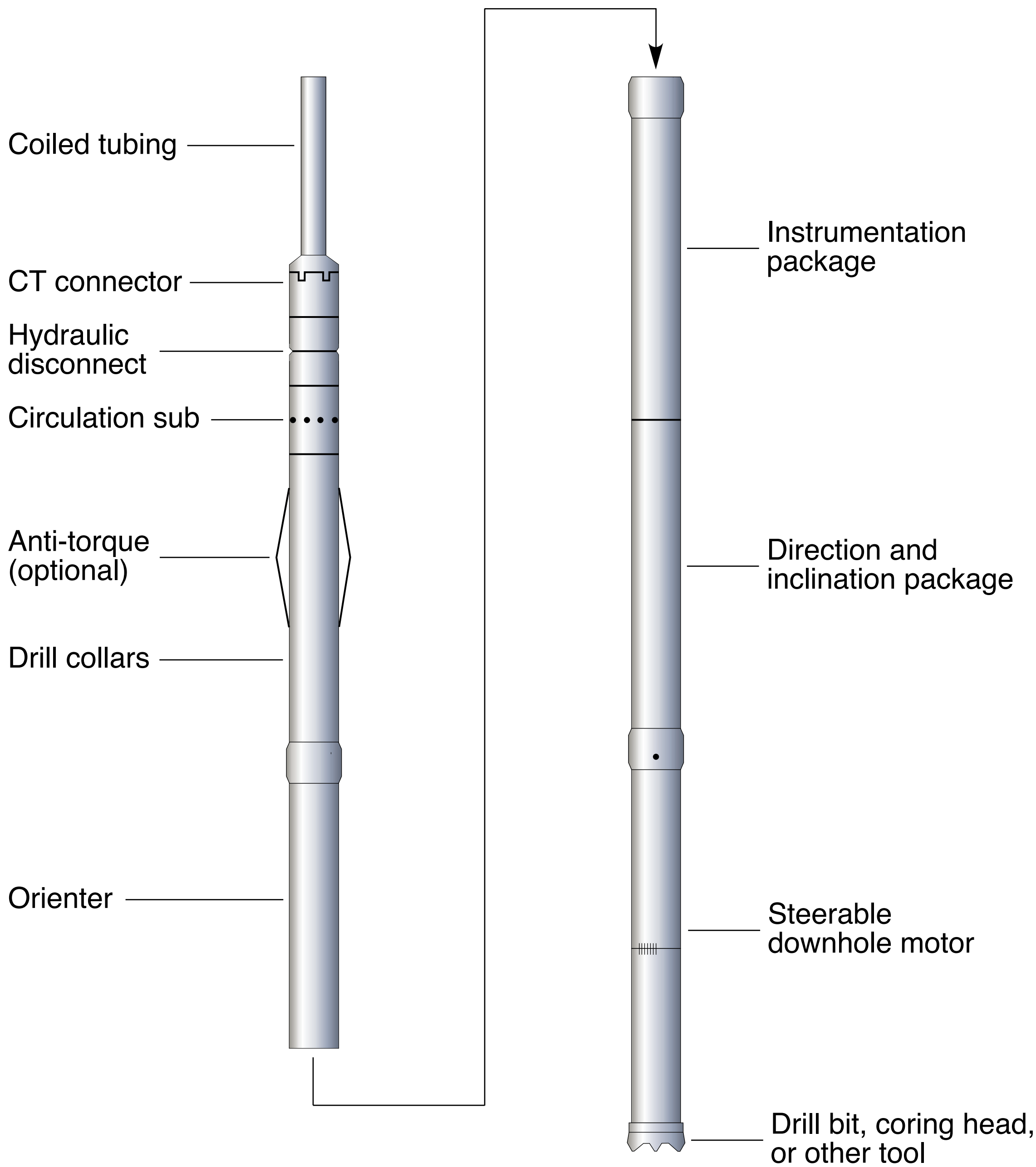


Primary components of the CTDI (fast access) drilling system.

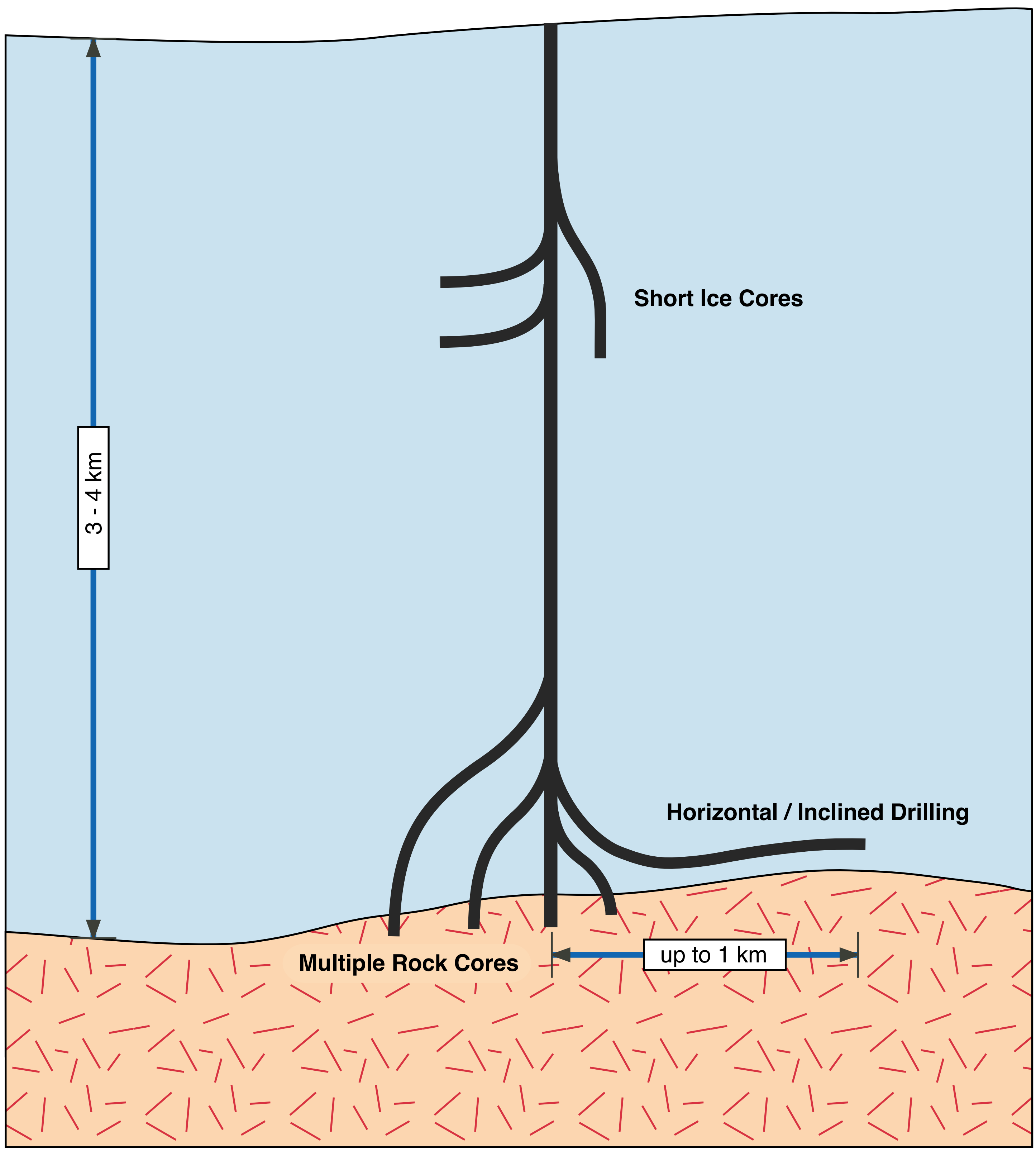
Field Layout
Sled-Mounted 3.5-km CTDI Drilling System



Detail of Bottom Hole Assembly



Directional Drilling / Coring Capabilities
CTDI Drilling System



Comparison of the weights and times required to drill a 3.5-km borehole through ice using ice-coring, hot-water, and CTDI drilling systems.

	ICD†	HWD‡	CTDI
Drill Weight (kg)	45,000	227,000	26,000
Drilling Fluid (kg)	91,000	0	17,000
Fuel (kg)	5,000	45,000	3,000
Total Weight, Drill + Fluids (kg)	141,000	272,000	46,000
Field Portability	no	limited	yes
Hole Diameter (cm)	18	~ 30	7.9
Effective Drilling Rate ($m \cdot hr^{-1}$)	1.7	30	40
Total Drilling Time§ (days)	$\geq 10^3$	10–12 *(30)*	6–8 *(4)*
Time Hole Remains Open	indefinite	2–3 days	indefinite

† Based on USA's 13-cm ice-coring drill.

‡ Based on the new Wotan hot-water drill (Koci, 2001); the existing AMANDA hot water drill does not have the power to reach 3.5 km.

§ Total borehole production time including rigging-up and rigging-down, on-bottom drilling time, downtime, and miscellaneous activities. Numbers in parentheses indicate the number of additional days needed to setup for the first hole of an array.