CORK Borehole Observatory Data from the Costa Rica Subduction Zone, Ocean Drilling (ODP) Holes 1253A and 1255A, doi: 10.60521/332595 and doi: 10.60521/332596

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About the Data:

This explanatory note pertains to four ASCII datasets from two CORK-II borehole observatories off Costa Rica that contain pressure values measured at 10 minute intervals at the seafloor and at two levels in the formation, and temperature values measured hourly at the seafloor. Ocean Drilling Program (ODP) Hole 1253A is located in the subducting Cocos plate just seaward of the subduction prism toe, and Hole 1255A is located roughly 800 m landward in the outer subduction prism (see Table 1 for locations and other information). Installations were completed in 2002 during ODP Leg 205 (Morris et al., 2003). Lithology, structure, technical details, rationale for the monitoring experiment, and scientific results can be found in that publication and others listed below. Key site information is summarized here in Table 1. The data should be of interest to scientists studying seismogenic processes at subduction zones and to oceanographers studying water mass dynamics.

Each of the two CORK pressure monitoring instrument systems included three Paroscientific 8B7000-2 Digiquartz absolute pressure gauges and a separate temperature sensor on the inside of the data logger pressure case. The data loggers were constructed by E. Davis, R. Meldrum, and R. Macdonald at the Pacific Geoscience Center (Geological Survey of Canada) with electronics produced by Richard Brancker Research, Ltd. (Ottawa). The units had an expected battery lifetime of 15-20 years (i.e., somewhat longer than the roughly 10-year period of data reported here), and their lifetimes can be extended with

external power using the electrical connector used for download operations. The Paroscientific gauges include internal temperature-sensitive quartz crystals that allow for temperature compensation of the pressure-loaded crystals. The loggers and all gauges are mounted in removable wellhead instrument assemblies. Formation sensors are connected via ¼" stainless steel tubing to sampling screens at independent formation depths (Table 1, and see Jannasch et al., 2003 for details). The line format for each pressure data file consists of date and time (UTC), and pressures (kPa) in sequence from the deepest formation-zone gauge up to the seafloor gauge (referred to as S1, S2, SF, respectively; Table 2). Format for data logger temperature (°C) is similar (Table 3).

To facilitate sampling of formation fluids two osmotic samplers were installed in a packed off section in 1253A and one in 1255A. For details see Jannasch et al. (2003).

Data were collected during four visits using the deep sea research submersible Alvin in 2002, 2004 and 2009, and the remotely operated vehicle Jason in 2013, each deployed from the research vessel Atlantis. The downloaded pressure- and temperature-data files collected during these visits have been merged for this posting. During the data recovery operations, logger-clock drifts were assessed, and at operator discretion, the clocks were reset to UTC. A summary of clock checks, resets, and clock drift rates is provided in Table 4.

Also as part of submersible operations, the relative offsets among the gauges were checked using wellhead valves that allow each formation gauge to be switched to a seafloor input for a short period of time (hours to days). Results of these checks are given in Table 5. Finally, at operator discretion, the logger memories were cleared at the end of the communications.

We note that the S1 borehole data from Hole 1255A were adversely compromised by leakage of seals likely associated with removal of fluid sampling instruments in 2004. This, and another disruption are noted in Table 5.

PLEASE NOTE that NO hydrostatic corrections or clock drift corrections have been applied to the posted data files. Such corrections have been done in studies referenced below, but any future user may choose to use their own method in applying such corrections.

How to cite:

If you utilize the Costa Rica CORK-II data from this posting in any publications, please acknowledge support from the Ocean Drilling Program (ODP), Geological Survey of Canada, the National Science Foundation Division of Ocean Sciences (NSF grants OCE-25145 and 1130146 to Miriam Kastner at the Scripps Institution of Oceanography), and the German Science Foundation (DFG) who funded the participation of Heinrich Villinger (University of Bremen, Germany) in ODP-Leg 205. The data set should be cited as follows:

Davis, E.E., and Villinger, H., CORK Borehole Observatory Data from the Costa Rica Subduction Zone, Ocean Drilling (ODP) Holes 1253A and 1255A, doi: 10.60521/332595 and doi:10.60521/332596.

Related publications (ordered by date of publication):

Morris, J.D., Villinger, H.W., Klaus, A., and the Shipboard Scientific Party (2003), Fluid flow and subduction fluxes across the Costa Rica convergent margin: Implications for the seismogenic zone and subduction factory, Proceedings of the Ocean Drilling Program, Initial Reports, 205: College Station, TX (Ocean Drilling Program).

Jannasch, H.W., Davis, E.E., Kastner, M., Morris, J.D., Pettigrew, T.L., Plant, J.N., et al. 2003. CORK II: long-term monitoring of fluid chemisty, fluxes, and hydrology in instrumented boreholes at the Costa Rica subduction zone. *In* Proceedings ODP, Inititial Reports, 205. *Edited by* J.D. Morris, H.W. Villinger and A. Klaus.

Shipboard Scientific Party, 2003. Leg 205 summary. In Morris, J.D., Villinger, H.W., Klaus, A., et al., Proc. ODP, Init. Repts., 205: College Station, TX (Ocean Drilling Program), 1–75. doi:10.2973/odp.proc.ir.205.101.2003

Davis, E. E., and H. W. Villinger (2007), Transient formation fluid pressures and temperatures in the Costa Rica forearc prism and subducting oceanic basement: CORK monitoring at ODP Sites 1253 and 1255, Earth Planet. Sci. Lett., 245, 232–244

Thomson, R.E., Davis, E.E., Heesemann, M., and Villinger, H. 2010. Observations of long-duration episodic bottom currents in the Middle America Trench: evidence for tidally initiated turbidity flows. Journal of Geophysical Research: Oceans, **115**: C10020. doi:10.1029/2010JC006166.

Davis, E.E., Heesemann, M.L., and Wang, K. 2011. Evidence for episodic aseismic slip across the subduction seismogenic zone off Costa Rica: CORK borehole pressure observations at the subduction prism toe. Earth and Planetary Science Letters, **306**: 299–305. doi:10.1016/j.epsl.2011.04.017.

Davis, E.E., Villinger, H., and Sun, T. 2015. Slow and delayed deformation and uplift of the outermost subduction prism following ETS and seismogenic slip events beneath Nicoya Peninsula, Costa Rica. Earth and Planetary Science Letters, **410**: 117–127. doi:10.1016/j.epsl.2014.11.015

Jiang, Y, Liu, Z., Davis, E., Schwartz, S., Dixon, T., Voss, N., et al. 2017. Strain release at the trench during shallow slow slip: the example of Nicoya Peninsula, Costa Rica. Geophysical Research Letters, **44**: 4846–4854. doi:10.1002/2017GL072803.

Thomson, R.E., and Davis, E.E. 2017. Equatorial Kelvin waves generated in the western tropical Pacific Ocean trigger mass and heat transport within the Middle America Trench off Costa Rica. Journal of Geophysical Research: Oceans, **122**: 5850–5869. doi:10.1002/2017JC012848.

Sun, T., Davis, E.E., Wang, K., and Jiang, Y. 2017. Trench-breaching afterslip following deeper coseismic slip of the 2012 Mw 7.6 Costa Rica earthquake constrained by near-trench pressure and land-based geodetic observations. Earth and Planetary Science Letters, **479**: 263–272. doi:10.1016/j.epsl.2017.09.021.

Davis, E.E., Sun, T., Becker, K., Heesemann, M., Villinger, H., and Wang, K. 2025. Deep-sea borehole fluid pressure and temperature observations at subduction zones and their geodynamic implications. Canadian Journal of Earth Sciences. 62(4): 684-709. doi:10.1139/cjes-2024-0093.

Becker, K., Davis, E.E., Andrew Fisher, A.T., and Villinger, H. 2025. Monitoring subseafloor temperature and fluid pressure in sealed ODP/IODP boreholes to constrain in situ hydrological state and processes in igneous oceanic crust. Canadian Journal of Earth Sciences. 62(4): 658-683. doi.org/10.1139/cjes-2024-0076

Sun, T., and Davis, E.E., 2025. Strain Accumulation Associated with Locked Subduction Megathrusts Revealed by Deep-Ocean Borehole Observations, Science Advances, in review.

Table 1. Summary of installation details of 1253A and 1255 CORK-II

CORK-II	1253A	1255A
Latitude / Longitude	9° 38.858’ N / 86° 11.434’ W	9° 39.272’ N / 86° 11.149’ W
Installation date	10 Oct 2002	1 Nov 2002
Lower screen depth (mbsf)	500.4	140.2
Upper screen depth (mbsf)	472.9	129.3
Seafloor depth (m)	4376.3	4311.6

Note: Seafloor sensors are located roughly 2 m above seafloor. Screen depths (mbsf = meters below seafloor) are given at screen centers. See Jannasch et al., (2003) for screen lengths, packer depths, and other details.

Table 2. CORK-II pressure data file format (example from ODP Hole 1253A).
The line format for each pressure data file consists of date and time, and pressures in sequence from the deepest formation-zone gauge (S1), a gauge at an intermediate depth level (S2) up to the seafloor gauge (SF). See Jannasch et al., 2003 for details.

Date (yy/mm/dd)	Time (HH:MM:SS UTC)	Pressure S1 (kPa)	Pressure S2 (kPa)	Pressure SF (kPa)
02/11/21	19:00:00	44537.297	44531.008	44537.152
02/11/21	19:10:00	44537.891	44531.445	44537.945
02/11/21	19:20:00	44538.367	44531.961	44538.844
02/11/21	19:30:00	44538.816	44532.398	44539.605
02/11/21	19:40:00	44539.168	44532.840	44540.238
02/11/21	19:50:00	44539.535	44533.207	44540.871
02/11/21	20:00:00	44539.965	44533.645	44541.586

Table 3. CORK-II seafloor temperature data file format (example from ODP Hole 1253A).

The line format for each temperature data file consists of date and time, counts (output of the A/D converter) and temperature at the seafloor. Counts are converted to temperatures using the following equation:

$temperature=6.46804301*10^{-14}*(counts^2) - 5.56269844*10^{-6}*counts + 44.1103$

The coefficients for the conversion are based on the data sheet of the used temperature sensors (thermistors). See Jannasch et al., 2003 for details.

Date (yy/mm/dd)	Time (HH:MM:SS UTC)	Counts	Temperature (°C)
02/10/12	01:00:00	8390026	1.9921
02/10/12	02:00:00	8389978	1.9923
02/10/12	03:00:00	8390063	1.9920
02/10/12	04:00:00	8390043	1.9921
02/10/12	05:00:00	8390050	1.9920
02/10/12	06:00:00	8390063	1.9920
02/10/12	07:00:00	8390099	1.9918

Table 4. Costa Rica CORK-II clock drift summary (all times UTC)

	Clock check	Clock offset (min)	Reset	Estimated clock drift rate (ppm)
2002				
1253A	N.A.	N.A.	2002-11-21 18:01:55	
1255A	N.A.	N.A.	2002-11-21 19:36:50	
2004				
1253A	exact time not recorded	02:29 fast	2004-03-01 20:36:30	3.7
1255A	N.A.	N.A.	N.A.	
2009				
1253A	2009-02-10 17:41:00	09:57 fast	2009-02-10 17:33:00	3.8
1255A	2009-02-10 20:54:00	16:23 fast	2009-02-10 20:39:00	5.0
2013				
1253A	2013-12-15 22:04:40	08:54 fast	2013-12-15 23:04:00	3.5
1255A	2013-12-16 00:53:50	13:02 fast	2013-12-16 01:52:50	5.5

Note: Because of the long elapsed time between clock syncs, considerable timing errors developed. Correcting the clocks, which ran fast at both sites, results in the existence of duplicate samples for the same time - with different values of course. This shows up as "wrinkles" in the merged pressure data at the time of clock resets. This does not occur in the hourly sampled temperatures.

Table 5. Costa Rica CORK-II Hydrostatic checks

	Check time (UTC)	Offset (kPa) (formation relative to seafloor) S1	S2	Remarks
2004				
1253A	2004-02-29 ca. 16:00	- 2.2	0.0	
1255A	2004-03-02 ca. 20:00	- 8.9	- 3.1	
2009				
1253A	2009-02-09 ca. 19:00	(- 8.3)	- 2.2	S1 offset not reliable
1255A	2009-02-10 ca. 18:30	- 11.4	- 2.7	No tidal signal attenuation at S1
2013				
1253A	2013-12-15 ca. 21:30	- 0.16	+ 0.4	
1255A	2013-12-15 ca. 06:00	-12.2	- 2.5	No tidal signal attenuation at S1

Seal failures:
1255A S1: 2004-09-06 16:10 (at time of osmosampler recovery)
1255A S2: 2011-03-16 16:20 (partial, spontaneous)