"Strike-slip Faults Mediate the Rise of Crustal-Derived Fluids and Mud Volcanism in the Deep Sea"

The supplementary material contains a detailed list of locations and pore water endmember data from various cores (A1), a summary of methods applied (A2), radiogenic strontium data of mud breccia clasts (A3), and background heat flow measurements (A4).

A1: Location data, fluid concentrations and isotope composition of selected endmembers from the ATI MVs and a re-sampled site at Porto MV (RV Meteor Cruise M86/5). For comparison, data from MV cores located on the accretionary wedge are also provided: [+] RV Maria S. Merian Cruise MSM1-3 (Scholz et al., 2009; Haffert et al., 2013), [#] RV Sonne Cruise SO 175 (Hensen et al., 2007). Cl^* is calculated from linear correlation to $\delta^{18}O$ ($Cl = 549.54 - 41.14 \cdot \delta^{18}O$; modified after Hensen et al. (2007) f_{Clay} is the fraction of water derived from clay-mineral dehydration and is calculated assuming a binary mixing between freshwater (Cl = 0 mM) and seawater (Cl = 550 mM). GH = Core with gas hydrate occurrence; WD = Water Depth; CL = Length of core; SD = Sediment Depth of sample. Italic numbers indicate pore water chloride concentrations showing the influence of evaporite dissolution at these sites.

Location	Station Nº	Lat. (N)	Long. (W)	WD [m]	CL [cm]	SD [cm]	Cl [mM]	Cl^* [mM]	Li [µM]	B [mM]	Sr [µM]	K [mM]	CH_4 mM	$\delta^{18}O$ [‰]	δD [‰]	$^{87}Sr/^{86}Sr$	f_{Clay}
M. Ivanov (GH)	100	35°44.34	10°12.06	4497	94	67	449.9	-	93.01	3.27	978.95	2.38	1.7	2.22	-9.22	0.70737	0.18
M. Ivanov MV	24	35°44.33	10°12.06	4488	238	218.5	482.1	-	101.51	2.44	830.51	5.44	0.12	1.50	-5.54	0.70759	0.12
Tiamat MV	27	35°45.72	10°21.25	4564	454	433	499.5	-	128.08	2.02	546.51	6.81	12.1	0.98	-4.93	0.70771	0.09
Abzu MV	28	35°45.03	10°19.03	4558	475	413	507.1	-	48.92	1.40	595.96	7.82	8.7	0.64	-2.93	0.70742	0.08
Porto MV	08	35°33.71	09°30.44	3866	195	158.5	351.0	-	248.18	6.82	386.11	2.50	8.8	2.2	-15.5	0.70755	0.36
Porto MV [+]	143	35°33.70	09°30.44	3860	120	115	343.8	-	203.31	7.14	451.22	4.38	1.0	2.45	-15.60	0.70753	0.37
CRMV [+]	154	35°47.26	08°25.36	2198	242	20	332.3	-	129.70	8.60	304.10	1.80	3.7	4.4	-9.3	0.70832	0.40
Bonjardim MV [#]	9051-2	35°27.61	09°00.03	3087	263	212	332.0	-	487.94	7.09	354.82	1.36	3.5	5.43	-18.93	0.70863	0.40
Bonjardim MV [+]	130	35°27.82	09°00.14	3049	296	260	418.0	-	235.20	6.19	289.40	5.70	1.1	3.06	-8.00	0.70869	0.24
CAMV [#]	9041-1	35°39.70	07°19.97	1316	235	215	*606.1*	164.5	690.98	14.36	862.81	2.50	5.2	9.36	-22.80	0.70991	0.70
CAMV [#]	9072-1	35°39.71	07:19.95	1321	325	215	*606.1*	194.5	634.90	12.86	792.23	2.66	5.4	8.63	-19.71	0.70992	0.65
Mercator MV [+]	239	35°17.92	06°38.70	353	210	196	*4343.7*	263.1	2912	9.87	738.74	8.50	1.0	6.96	-18.22	0.71063	0.52
Mercator MV [+]	263	35°17.87	06°38.80	351	155	141	*5250.6*	206.7	3357	11.09	828.20	10.40	1.4	10.34	-22.94	0.71063	0.62

A2: Approach and Methods

Field work was essentially concentrated on pre-selected acoustic backscatter anomalies that were detected in compilations of swath-bathymetric data from successive cruises in the area (Zitellini et al., 2009). During M86/5 high-resolution sidescan sonar mosaics were recorded of numerous seafloor features using the Autonomous Underwater Vehicle (AUV) ABYSS from Helmholtz Centre for Ocean Research Kiel (GEOMAR) equipped with an Edgetech sidescan sonar system running at 120/410 kHz resulting in a resolution of less than 1 m at the seafloor.

Heat flow has been measured on the cruise using a 6 m long heat flow probe.

Gravity cores were cut into 1 m long segments and split lengthwise into an archive half for visual description and a work half for sampling and geochemical analyses. Pore waters were extracted from the sediments at ambient temperature using a squeezing device operated with argon gas at pressures up to 5 bar. Upon squeezing, pore waters were filtered through 0.2 µm cellulose acetate membrane filters. Concentrations of chloride were measured on-board by ion-chromatography (IC, METROHM 761). Acidified subsamples were stored in pre-cleaned vials for shore-based analyses of cations by inductively coupled plasma optical emission spectrometry (ICP-OES, VARIAN 720-ES). All analytical methods applied routinely at GEOMAR are available at http://www.geomar.de or in various publications (Hensen et al., 2007; Scholz et al., 2009).

Recovery of dissolved light volatile hydrocarbons was performed by headspace equilibration (Hensen et al., 2007). The concentrations were measured by gas chromatography-flame ionization detection using a Shimadzu 14B gas chromatograph fitted with a mega-bore PLOT Q Capillary column (0.53mmx25m).

A number of rock clasts from cores taken at ATI MVs and MVs on the accretionary wedge were collected for Sr isotope analysis of the silicate fraction (A3). For this purpose calcium carbonate of freeze-dried and ground samples was driven out by treatment with 15 ml

4M acetic acid for 24h. The remaining fraction was then fully digested in an acid mixture consisting of $HClO_4$, HNO_3 and HF.

Stable isotopes of oxygen and hydrogen were analysed at UFZ using a laser-based Picarro L2130-i system with high-precision vaporizer, two reference standards and one procedural standard. The results are reported relative to VSMOW with a precision (2sigma) of ±0.8‰ for δD and ±0.25‰ for $\delta^{18}O$. Sr isotope ratios ($^{87}Sr/^{86}Sr$) were measured by thermal ionization mass spectrometry (TIMS, TRITON, ThermoFisher Scientific) at the Helmholtz Centre for Ocean Research Kiel (GEOMAR) after separation of > 1500 ng Sr per sample via ion exchange chromatography using SrSpec resin (Eichrom) at whole procedure blanks of max. 800 pg (silicate digestion). Repeated analyses of the standard NIST SRM 987 were used for normalisation to an $^{87}Sr/^{86}Sr$ value of 0.710248 at a reproducibility of ± 0.000020 (2SD).

A3: Radiogenic strontium isotopes of clasts in mud breccias. $^{87}Sr/^{86}Sr$ from leacheates roughly represents the carbonate fraction of clasts. Carbonate fractions were removed in order to avoid biasing of the clay signal. The full digestion of the residual material represents the clay (silicate) fraction. Two carbonate samples were retrieved during the R/V Professor Logachev Training-Through-Research cruise TTR 10 (Magalhaes et al., 2012).

Location	Cruise	Station N°	$^{87}Sr/^{86}Sr$ leach	$^{87}Sr/^{86}Sr$ digest
M. Ivanov MV	M86/5	24	0.70767	0.70967
M. Ivanov MV	M86/5	101	0.70769	0.71189
M. Ivanov MV	M86/5	101	0.70770	0.71210
Porto MV	M86/5	08	0.70830	0.71655
Porto MV	M86/5	08	0.70875	0.71470
CRMV	TTR 10	243G/244G	0.70782	0.70994
CRMV	TTR 10	243G/244G	0.70808	0.71344

A4: Heat flow data from two stations of M86/5 are shown to characterize the regional background. Station M86/5-26-2 (Hf1) was measured in the vicinity of M. Ivanov MV and station M86/5-71-2 (Hf2) is a reference station in the Horseshoe Abyssal Plain. The measured geothermal gradients at both stations are about 45 K km^{-1} and in agreement with data from Grevemeyer et al. (2009) who measured 47-51 K km^{-1} (GeoB 9046) located west of the deformation front of the accretionary wedge.