ALMAHATA SITTA SAMPLE MS-MU-011: A RAPIDLY CRYSTALLIZED ANDESITE FROM THE CRUST OF THE UREILITE PARENT BODY

A. Bischoff[1], M. Horstmann[1], A. Pack[2], D. Herwatz[2], and S. Decker[3].

Institut für Planetologie
Westfälische Wilhelms-Universität Münster

E-mail: bischoa@uni-muenster.de.

[1]Institut für Planetologie, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany.
[2]Universität Göttingen, Goldschmidtstr. 1, 37077 Göttingen, Germany.
[3]Meteorite Museum, Oberstr. 10a, 55430 Oberwesel, Germany.

Westfälische Wilhelms-Universität Münster

Introduction

Ureilites are primitive achondrites whose oxygen and osmium isotopes link them to the carbonaceous chondrites [1,2]. They are interpreted to represent predominantly asteroidal mantle restites dominated by olivine and pyroxene, and lack feldspar [e.g., 3,4]. Ureilite petrogenesis is poorly understood and heavily debated [e.g., 3,4]. Although minor feldspathic fragments have been reported in polymict ureilites [e.g., 3,5,6], a meteorite sample of basaltic or andesitic melt - complementary to the mafic ureilites - representing crustal material from the ureilite parent body has never been found. Recently, Almahata Sitta provided numerous fresh meteorite fragments including both various chondritic and achondritic (ureilitic) lithologies representing a wealth of different parent lithologies [7-10]. Among the Almahata Sitta samples one feldspar-rich fragment, MS-MU-011, was identified, which was found in October 2009 in the Nubian Desert (Fig. 1). Here, first results on its mineralogy, mineral chemistry, and oxygen isotope composition are presented (Figs. 2-5). The results suggest that MS-MU-011 is the first large sample representing the ureilite parent body crust.

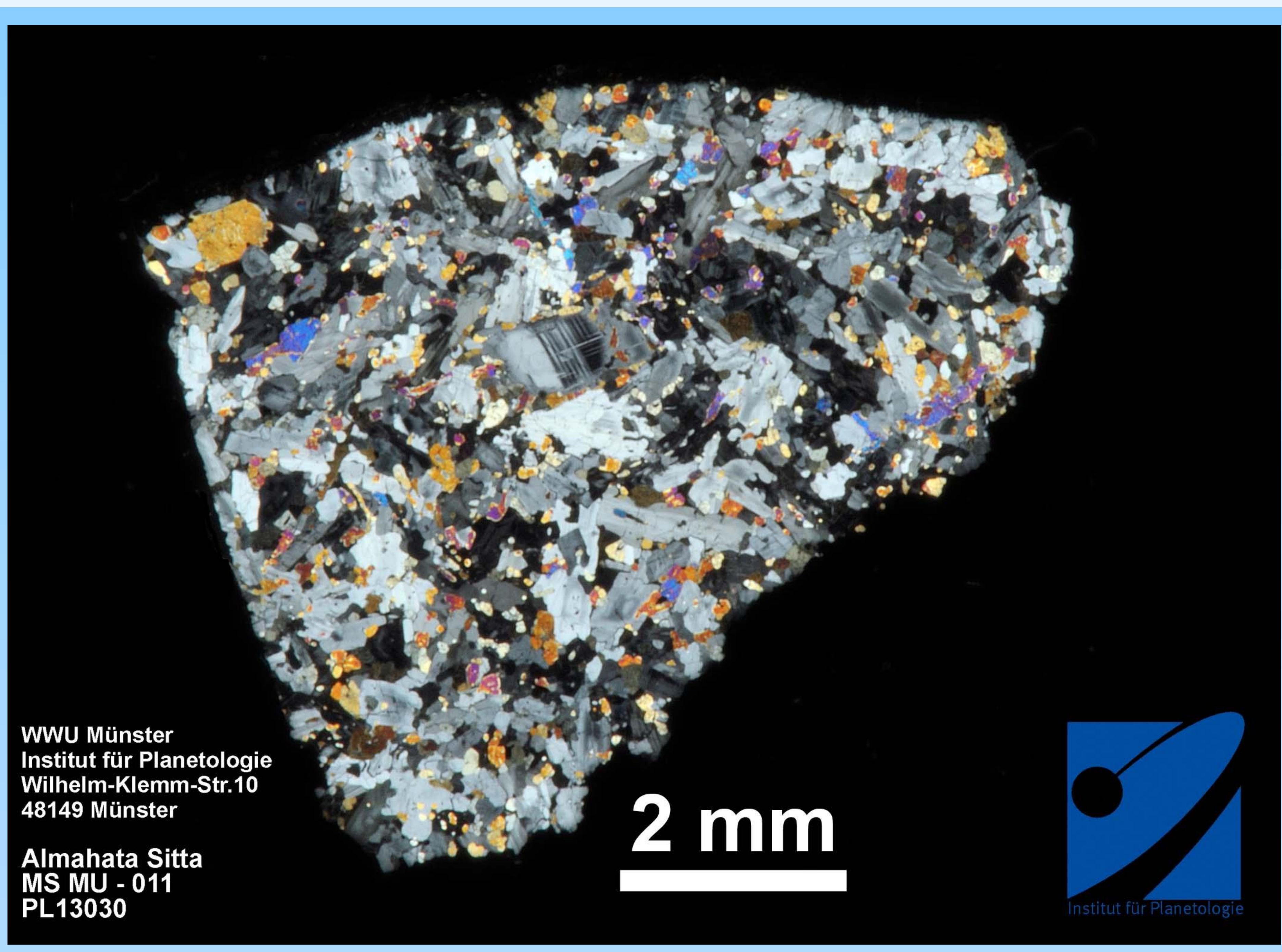

Fig. 3: Thin section of the Almahata Sitta fragment MS-MU-011 showing the plagioclase- (mainly grey) and pyroxene-rich rock.

Fig. 1: Almahata Sitta fragment MS-MU-011 as found in the Nubian Desert 2009.

Mineralogy

Based on its greenish color the 24.2g MS-MU-011 specimen was, although having a fusion crust, at first considered as a doubtful meteorite specimen. The thin section inspection revealed that it is an andesite having abundant (~70 vol%) subhedral, strongly-zoned plagioclase laths (~An_{10-55}; Fig. 5) embedding Cr-bearing (Cr_2O_3: ~1 wt%) Ca-pyroxene (~$Fs_{20-21}Wo_{36-37}$) and Ca-poor pyroxene (~$Fs_{35-37}Wo_{7-10}$). In most cases the molar Fe/Mn ratio is 15-20. As minor phases so far, euhedral Cl-apatite laths (Fig. 4), whitlockite, ilmenite, Ti,Cr,Fe-spinel, FeS, and metals are identified. The metals are basically Ni-free. Rare pockets of fine-grained FeS–Fe-metal intergrowths (up to ~30 µm) were detected. Based on the fast cooling SiO_2-normative melt inclusions (~4.5 wt% K_2O) were formed within large crystals (e.g., pyroxene) and fine-grained intergrowths of albitic plagioclase ($An_{<10}$), skeletal pyroxene, and a SiO_2-normative melt (with up to 4.5 wt% K_2O; perhaps glassy) occur in the interstices between the major minerals. Similar parageneses were found by [6].

Oxygen Isotopes

The oxygen isotope compositions of two sample aliquots were obtained by IR laser fluorination (Fig. 2). The results of $\delta'^{18}O$ = 8.08 ‰, $\delta'^{17}O$ = 3.23 ‰, $\Delta^{17}O$ = -1.061 ‰ and $\delta'^{18}O$ = 7.96 ‰, $\delta'^{17}O$ = 3.19 ‰, $\Delta^{17}O$ = -1.040 ‰ are clearly consistent with a ureilitic origin. The external reproducibility of the analyses is ±0.01 ‰ in $\Delta^{17}O$. Data fall on the CCAM with $\delta'^{17}O = 0.94\times\delta'^{18}O - 4.3$ ‰ (Fig. 2).

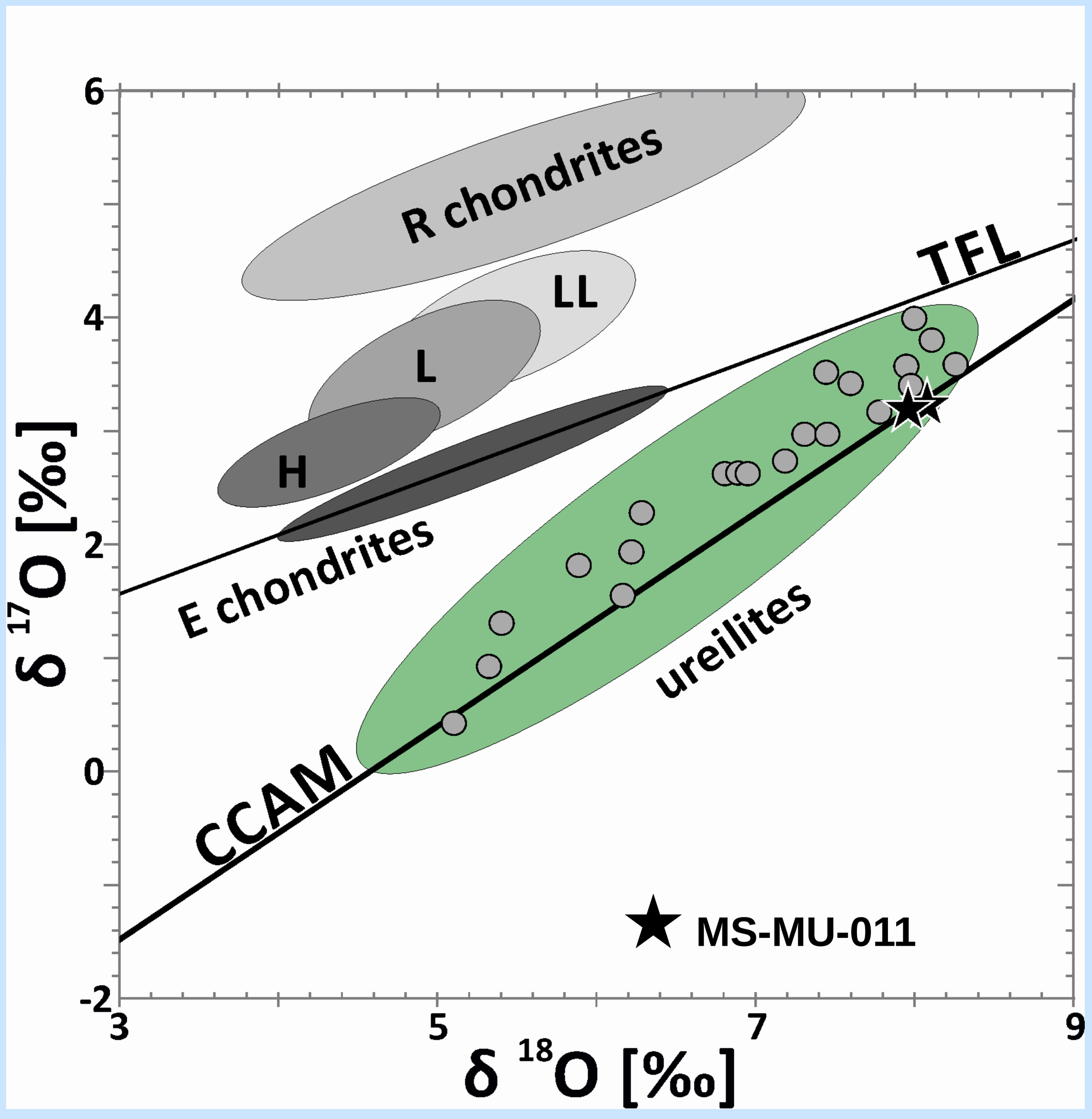

Fig. 2: Oxygen isotope composition of Almahata Sitta Fragment MS-MU-011. Data plot within the ureilite field and on the CCAM-line. Other Almahata Sitta ureilite data (circles) from [7, 10, 11].

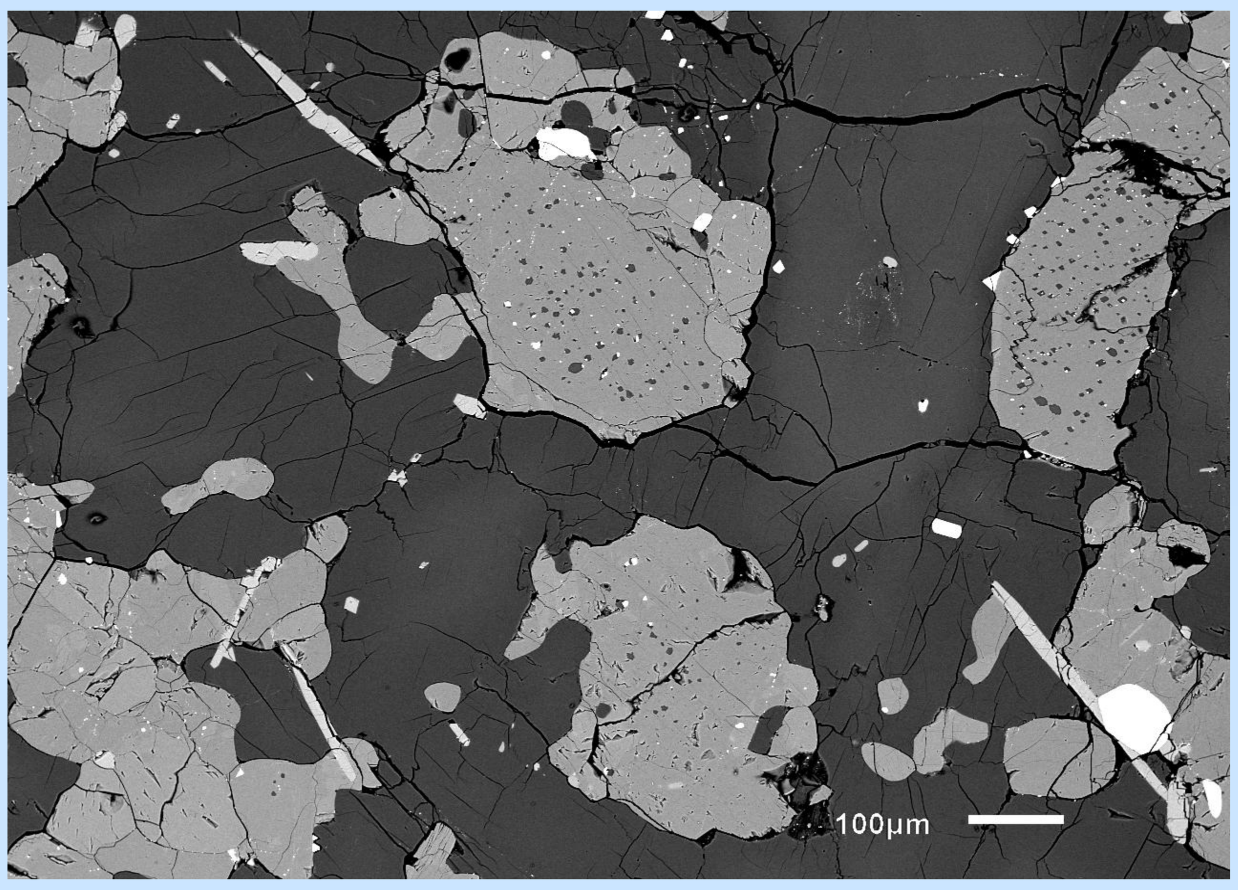

Fig. 4: Cl-apatite laths (light gray) within zoned plagioclase (dark grey) and pyroxene. Note the abundant inclusions in Ca-pyroxene (upper center). BSE Image.

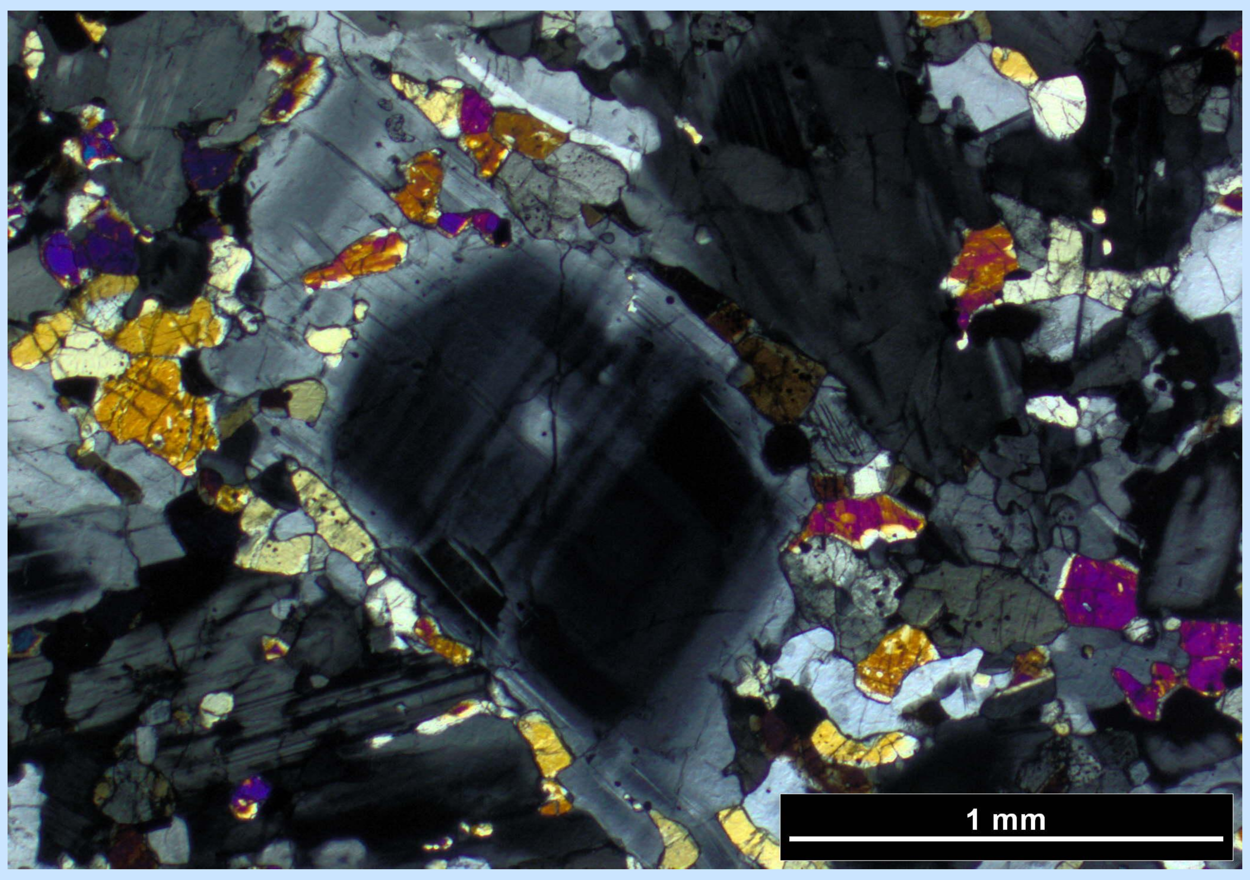

Fig. 5: Strongly-zoned plagioclase in MS-MU-011 with a core of ~An_{53} and a rim of ~An_{15} indicating fast cooling.

References: [1] Clayton R. N. and Mayeda T. K. 1996. *GCA* 60:1999-2017. [2] Rankenburg K. et al. 2007. *GCA* 71:2402-2413. [3] Goodrich C. A. et al. 2004. *Chemie der Erde* 64:283-327. [4] Warren P. H. et al. 2006. *GCA* 70:2104-2126. [5] Bischoff A. et al. 2006. *MESS II*:679-712. [6] Cohen B. A. et al. 2004. *GCA* 68:4249-4266. [7] Bischoff A. et al. 2010. *MAPS* 45:1638-1656. [8] Bischoff A. et al. 2012. *MAPS* 47:A71. [9] Horstmann M. et al. 2010. *MAPS* 45:1657-1667. [10] Horstmann M. et al. 2012. *MAPS* 47: A193. [11] Rumble D. et al. 2010. *MAPS* 45:1765-1770.

Acknowledgements: We thank Ulla Heitmann, Moritz Barth, Mona Weyrauch, and Frank Bartschat for technical support.