Hard X-ray Synchrotron Analytical Facilities in Support of NSF-EAR PIs at the Advanced Light Source: A Proposal for Dedicated Earth Sciences Staffing at ALS Beamlines 8.3.2, 12.2.2, and 12.3.2

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Three of the hard X-ray facilities at the Advanced Light Source (ALS), comprising beamlines 12.2.2 (Diffraction at Extreme Conditions), 8.3.2 (Microtomography), and 12.3.2 (Micro/Laue Diffraction), propose to make their facilities substantially more accessible to Earth and Environmental Sciences users through targeted staffing coupled with Approved Program arrangements with the ALS facility. This arrangement builds on the past success of 12.2.2, which has been staffed by 2-3 COMPRES-funded FTE over the last 17 years. This program provided beamtime availability for the high-pressure Earth Sciences community and resulted in excellent scientific productivity coupled with new and novel technique development. The 12.2.2 COMPRES effort has also leveraged *very* substantial DOE-funded human and infrastructure resources from the ALS facility. This proposal requests that this highly successful program be continued at its current level (2 FTE). Other enterprises at the ALS have Earth Science scientific and leveraging opportunities comparable to those that 12.2.2 has enjoyed, and this proposal includes two other beamlines that have already shown substantial appeal to, and capabilities for, Earth and Environmental Sciences (EES) users. These are the Microtomography (8.3.2) and Micro/Laue Diffraction (12.3.2) beamlines. The former can characterize the three-dimensional structure of polyphase materials with an accuracy of ~1 μm, and the latter can map grain orientation, structure, strain/stress, and phase distribution at the sub-micron level. A recent summit of ALS NSF-EAR funded users highlighted a wide range of Earth and Environmental Sciences projects conducted on both 8.3.2 and 12.3.2, spanning from characterizations of porosity geometries, to magmatic vesiculation and crystallization processes, to the nature and formation of biogenic mineral layers. Indeed, all three of these beamlines have developed novel experimental cells/apparatuses that can be deployed on behalf of EES users. Yet, while NSF-funding has facilitated broad numbers of EES users at 12.2.2, the usage of 8.3.2 and 12.3.2 by EES investigators has been primarily confined to a small handful of power-users, typically centered either at LBNL or UC Berkeley: the latter are predominantly funded by NSF-EAR. While these power-users have generated high-impact studies, dedicated EES staffing combined with potential Approved Program status at each of these beamlines will allow ***far*** greater access and utilization by NSF-EAR users. In short, each of these beamlines brings powerful, highly EES-relevant tools to bear on state-of-the-art geosciences problems. The principal limitations that we have identified are staffing and user-outreach related, as both of these beamlines are supported by a single ALS FTE. These limitations can be overcome via a dedicated, Earth Sciences-centered staff member at each beamline. This proposal seeks to make these facilities more readily available to a much broader swath of the Earth Sciences community. Therefore, while continuing with the highly successful staffing of 12.2.2, we request 2 additional FTEs, with one each deployed at 8.3.2 and 12.3.2. The benefits to the scientific community of this enhanced investment will span from paleontology and the biogeosciences, through volcanology and structural geology, to key characterizations of fluid distributions within the varying environments of Earth's crust and mantle.