Abstract. We investigate planetary bodies to understand the formation, evolution, and composition of our solar system. Remote sensing, in situ probes, and sample return missions each provide different perspectives in developing an understanding of the characteristics of planetary bodies and hence the processes at work in shaping them. As new planetary missions are planned within tight budgetary constraints, a natural tension develops between the costs and scientific value of sample return versus in situ or remote sensing approaches. Without doubt, some things can best (or only) be done in situ (e.g., measuring atmospheric pressure, wind, and volatiles) and the global overviews associated with remote sensing missions cannot be neglected. However, sample return science can provide a much more detailed picture of very specific aspects; for example the accuracy, precision, and resolution needed to verify dates of materials cannot be done by either orbiting or in situ missions. The examination of material properties, from bulk analysis to coordinated assessment at the nanoscale, provides insight into recorded solar system processes that are important to our understanding of the formation and evolution of our solar system. The required instruments cannot be “flown” – we need to have samples here in laboratories on Earth. In this way samples can provide a kind of “ground truth” that adds either additional detail or credibility to in situ and remote sensing analysis.

An extremely important rationale and benefit for sample return is the high science return available for the mission investment due to reproducibility of results and broad access by the science community. With careful sample curation the value of samples are also preserved to take advantage of eventual advent of new analytical techniques and approaches for new analyses to answer future questions for decades. Low cost, high science value mission concepts trade the challenges, costs, and science return for sample return missions with those of landed, orbiting, and fly-by missions. Challenges for sample return involve technical issues in acquiring and containing material, mission and spacecraft design issues in transporting back to Earth, and science issues in defining sample pristinity requirements. With expensive instrument suites for in situ and remote sensing missions required to achieve similar scientific return sample return missions remain a viable low cost mission approach. Recent low cost sample return missions show the significance and potential of these mission types.

In the end, both the return of extraterrestrial samples and non-sample approaches provide the best way to get a more accurate understanding of a particular body, its place in our solar system, and insight into the processes and events associated with the formation and evolution of our solar system.