



## France–United States space cooperation – Curiosity celebrates two Mars years of roving

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**The Curiosity rover is celebrating its second Mars year on the surface of the Red Planet, almost four Earth years since touching down on 6 August 2012. It remains in good health and all of its instruments are working well. After driving 13 kilometres through Gale Crater, the rover is now scaling the layered sedimentary terrain on the lower slopes of Mount Sharp, which peaks at 5 kilometres above the base of the crater.**

**ChemCam (Chemistry Camera)** and **SAM (Sample Analysis at Mars)** are two French-U.S. instruments on Curiosity. Both instruments were built with CNES oversight by research laboratories attached to CNRS, the French national scientific research centre, and French universities. The IRAP astrophysics and planetology research institute was the lead laboratory for ChemCam and the LATMOS atmospheres, environments and space observations laboratory and the LISA interuniversity laboratory for the study of atmospheric systems were the leads for SAM. Scientists and engineers have now been operating the two instruments on the surface of the Red Planet for two Mars years from the French Instruments Mars Operations Centre (FIMOC) at the Toulouse Space Centre.

**ChemCam** has fired its power laser more than 337,000 times, revealing an unexpectedly diverse array of magmatic and sedimentary rocks. Its measurements have shown that some of these rocks are comparable to the Archeozoic formations composing Earth's primitive crust, completely changing our view of Mars' surface. ChemCam has also detected minerals that formed at a later stage through precipitation of phosphates, sulphates, calcium and manganese. It is also studying the planet's current environment with regular measurements of abundance variations in the water and carbon dioxide columns in the atmosphere.

The **SAM** instrument suite is a fully fledged laboratory designed to conduct in-situ analysis of Mars' surface and subsurface, and to collect and analyse samples of its atmosphere. The broad palette of analyses that SAM is able to carry out has yielded a wide variety of innovative results in two Mars years scouting the planet. In particular, it has enabled scientists to revise abundance models of compounds in the atmosphere, dated Gale Crater and exposed rocks analysed by Curiosity, detected the presence and then disappearance of water in the Hesperian period on Mars and found perchlorates everywhere on its surface, as well as organic compounds.

**Curiosity's discoveries.** The rover team has closely studied nine sites over the last two Mars years. Yellowknife Bay is a paleo-lake with stratified layers of sandstone several metres thick that have revealed that Mars was once habitable in its ancient past, the mission's main goal. The Darwin, Cooperstown and Kimberley sites have enabled the mission's science team to identify various fluvial and lacustrine episodes that would have required a climate very different to what we see today, with water present in large quantities. In the Pahrump Hills, Curiosity has studied the base of Mount Sharp and a succession of contact zones, between a lacustrine and an aeolian deposit (Marias Pass and Bridger Basin). The large sand dune now lying between the rover and the layered terrain of Mount Sharp is still active and has been sampled at the site called Gobabeb. Curiosity is currently on the Naukluft Plateau, where it is studying signs of strong erosion. The diverse composition of magmatic and sedimentary rocks is a major result for the mission, as it represents the

terrain surrounding the landing site and the surface crust.

CNES is collaborating with JPL on future Mars missions : Curiosity's successor and its SuperCam instrument and Insight, dedicated to the seismology of Mars.