PEOPLE IN ASTRONOMY

KATIE STACK MORGAN

Katie Stack Morgan is a Research Scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, California, who studies the ancient sedimentary rock record of Mars to understand the history of water and the potential for past life on the martian surface. Since 2012, Dr. Stack Morgan has been a member of the Mars Science Laboratory (MSL) Science Team operating the Curiosity rover in Gale crater. She is also the Deputy Project Scientist of the Mars 2020 mission, NASA's next flagship rover mission to Mars and the first mission in a series of potential missions dedicated to returning Mars samples to Earth.

Dr. Stack Morgan was born in Strasbourg, France, grew up in Cheshire, Connecticut, and attended Williams College where she earned her B.A. in Astronomy and Geosciences. Wanting to combine her interest in geology with a passion for exploration beyond our planet Earth, she continued her graduate studies in Geology at the California Institute of Technology. During her Ph.D. studies, she used high-resolution images from both Mars orbiters and the Curiosity rover to decipher the history of ancient sedimentary surface processes on Mars. She first became involved in the MSL mission as a graduate student, during which time she was tasked with proposing "waypoints," pre-planned stops dedicated to science analysis, for the Curiosity rover as it made its way along the 10-km-long traverse from its landing site to the base of Mount Sharp, the 5-km high mountain in the middle of Gale crater. Upon transitioning to a full-time research position at JPL, she led Curiosity's first campaign at Mount Sharp, contributing to the discovery of an ancient, habitable long-lived river and lake system within the crater. Now as Deputy Project Scientist for the Mars 2020 mission, Dr. Stack Morgan helps lead a team of 300+ scientists dedicated to collecting rock and soil samples on the surface of Mars for potential return to Earth.

How did you get interested in astronomy?

My interest in astronomy was first sparked in elementary school when my dad bought, and then read to me, a glow-in-the-dark book about constellations. My parents continued to support my interest by taking me to planetarium shows at every opportunity--including the grand opening weekend of the Rose Center for Earth and Space at the American Museum of Natural History in New York City! I wasn't exposed to much astronomy in school, so my interest developed mostly out of the classroom through reading astronomy books, watching space programs, and visiting museums.

How did your time at Williams enhance your interest in astronomy and planetary geology?

One of the main reasons I chose to go to Williams College was that it had a separate Astronomy and Astrophysics major and dedicated Astronomy faculty—most other small liberal arts colleges I considered only had general physics programs. At Williams, I had the good fortune in my first semester of college to have hands-on experience with the on-campus observing facilities, and later in college the opportunity to participate in summer research as part of the Keck Northeast Astronomy Consortium Research Experience for Undergraduates. These experiences were critical for putting me on the path towards a science career, and for building confidence in my ability to do research.

The most influential experience I had as an undergraduate was participating in a tutorial on Planetary Geology offered through the Geosciences department. Each week my tutorial partner and I would dig into the scientific literature on a particular topic in planetary geology, taking turns synthesizing and writing about the weekly topic. This was my first experience reading, thinking, and writing critically about scientific research and ideas, and I discovered that I really enjoyed it! This was also my very first introduction to the field of planetary geology, and as soon as I finished the course, I knew that this was exactly the right career path for me.

How did you get interested in Mars?

My first experience with Mars was during the close approach in August of 2003, when a few high school friends and I trekked out to a small observatory in the Connecticut woods

late at night to observe Mars at the closest to Earth it had been in 60,000 years, and the closest it would be for another ~300 years. But I had no idea then how important that fuzzy red dot would become for me! When I was searching for graduate programs, Mars research seemed like such a natural fit for me because the geology of ancient Mars is so Earth-like. With its evidence for ancient lakes, rivers, deltas, and sand dunes, Mars seemed like the perfect place to combine my interest in geology with my passion for studying other planets.

WHAT'S IT LIKE TO WORK AT JPL; WHAT WAS YOUR PATH LIKE AT CALTECH AND JPL?

I started off as a graduate student at Caltech, where, like many students before and after, I struggled to find my place in the world of fast-paced research. There were so many interesting questions out there to tackle, but I didn't know where or how to start! Those of us who study Mars are fortunate in that we have a bounty of high-resolution data from numerous orbiters, rovers, and landers that have observed the surface of Mars, but it can be intimidating for someone just entering the field who doesn't have experience using these datasets. It wasn't until I joined the MSL Science Team, and began preparing for Curiosity's impending arrival in Gale crater, that I really hit my research stride. I found quickly that there was a niche for researchers who could move nimbly between orbiter image observations of the surface—the "overhead" context view—and the rover's-eye view of the ground. I used the orbiter images to develop hypotheses and scientific models for the rover's future investigations, then switched to analysis of the rover data, and testing my predictions, once it arrived at the planned location.

As a member of the MSL Science Team, I was also able to experience first-hand how rovers are operated here on Earth by scientists and engineers. Although much of my time at Caltech was spent in a purely academic environment, I found that I felt most comfortable working as part of a diverse and multi-disciplinary team that involved scientists and engineers working together towards a common goal of exploring another planet. This discovery led me to pursue a research scientist position at JPL, where the development and operating teams for Mars missions like Curiosity are based. JPL is a very special place to work, and I feel incredibly fortunate to be one of the people behind the robotic exploration of our Solar System. It's not every workplace where you can tell what planet someone works on by the floor at which they get off of the elevator! JPL is such

a fertile place for ideas to spark, grow, and take hold, whether it's a brand new mission concept to an unexplored corner of the Solar System, a novel way to operate a Mars rover, or a new idea for how a planet's surface came to look the way it does today.

Please highlight your current Mars work.

My current research seeks to combine orbiter images and ground-based rover images to determine the geologic history of current and future landing sites on Mars. Geologic mapping is a tool that geologists have been employing for over two centuries on Earth to understand the origin of rocks and the evolution of processes on the Earth's surface. Geologic mapping is useful on other planets, too, though instead of walking around a field area making observations as we hike as we would on Earth, I make observations about the rocks at the surface of Mars using images taken by cameras onboard robotic spacecraft. Having completed a geologic map of the area that the Curiosity rover is exploring in Gale crater, I've turned my attention to Jezero crater and Northeast Syrtis, the future field sites for the Mars 2020 rover. I work with colleagues on the Mars 2020 Science Team to create geologic maps of the landing site to help guide our science exploration and sampling strategy once the rover arrives at the martian surface. Jezero crater, the landing site for Mars 2020, hosts a beautifully well-preserved delta whose sediments were sourced from a larger area of ancient Mars crust outside the crater. By developing models for how this delta formed, we can hypothesize where the best locations in the crater may be to search for evidence of past life and collect a diverse set of sample sites, before we even arrive on the surface with the rover.