Graduate student Leigh Ann Kesler is pursuing two great interests: rock climbing and fusion science. One day she finds herself scrambling up bare rock face to view grand vistas of mountains and valleys carved by glaciers, the next in the laboratory, focusing on minute changes in the depth of materials being eroded by fusion forces.

Kesler, who studies at MIT’s Plasma Science and Fusion Center (PSFC), dates her interest in fusion from an 11th-grade persuasive writing assignment. Inspired in part by her father’s interest in the potential of nuclear energy, she decided to investigate fusion. Although the library in her
Fisher, Illinois high school had only one book on the
topic, written in the 1970s, its description of a magnetic
fusion device called a tokamak was compelling enough
to hook her.

As an undergrad at the University of Illinois, Kesler
studied Nuclear, Plasma, and Radiological engineering,
learning the basics about how plasmas affect materials
from mentor Prof. David Ruzic. Working in his labora-
tory on projects related to semiconductor manufactur-
ing as well as fusion, she gained a reputation for expert-
tise with certain plasma diagnostics. Graduate students
several years her senior began to seek her help with
their projects.

“I don’t know if I was an expert,” she laughs, “but I had
several advantages. I had small hands. I could reach
inside of the bottom of the chamber [of the experiment].
I’d been there long enough that they knew I wasn’t
going to break things.”

Now at MIT she is continuing her interest in materials
science and fusion research under the guidance of
Nuclear Science and Engineering Department Head,
Prof. Dennis Whyte, Director of the PSFC, and Prof.
Zach Hartwig. As in Illinois, she works in a lab that
utilizes small-scale plasma devices for ex situ observa-
tion of plasma surface interactions.

Her main focus is erosion of materials inside fusion
devices, in which strong magnetic fields keep the hot
plasma fuel confined and away from the walls of the
vacuum chamber where fusion reactions occur. But the
plasma can still affect the walls, resulting in surface
erosion and other changes.

“It’s very difficult to determine exactly how a particular
kind of plasma discharge affects the interior material of
the machine. We can’t be sure of the amount of erosion
occurring at any particular moment,” Kesler says.
Erosion affects not only the wall materials, but also the
plasma itself, which can become contaminated by the
eroded materials. “If you are eroding or even melting
the surfaces you will eventually destroy the divertor,
which is designed to remove impurities from the
plasma.”

She works mainly on a 2 MV electrostatic accelerator
called DANTE in the Vault Laboratory for Nuclear
Science, part of the Center for Science and Technology
with Accelerators and Radiation (CSTAR), a shielded,
underground facility that allows her to work with a
deuterium ion beam. She also uses the Cambridge
Laboratory for Accelerator Surface Science (CLASS),
which provides her the versatility of using two ion
sources.

Kesler is searching for a way to measure on a shot-by-
shot basis what changes are happening on the interior
surface of the tokamak, to gain a better understanding
of how different plasma conditions affect surfaces. To
this end, she will use the accelerator to create “depth
markers,” which will help measure changes in the
metallic surfaces. She is working with tungsten, a
metal that will likely be used for the divertors of
future tokamaks.

“Accelerators can be used to implant stuff into the
surface of a material. You put a layer of something (like
boron) close to the surface and use it as a reference
point. If the location of this layer changes after interact-
ing with the plasma that means the amount of tungsten
on the surface has changed. Either something has been
added or something has been taken away.”

Kesler is still fine-tuning what that reference point will
be, what material to use, how to create the depth mark-
er, and how to use the accelerators to see how the
plasma has affected the surface. Her technique should
be applicable to any material, and will be relevant to
tokamaks around the world, allowing researchers to
diagnose the effect of each plasma shot as it happens.

Now at the beginning of her sixth year, Kesler is still
researching and writing, but starting to consider her
options after graduation. “An international postdoctoral
position in materials development would be great. But
I’m not so much interested in where I go as in doing
interesting work,” she observes. Ideally that work will be
situated not far from a mountain. As Kesler observes,
“There are always more rocks to climb.”