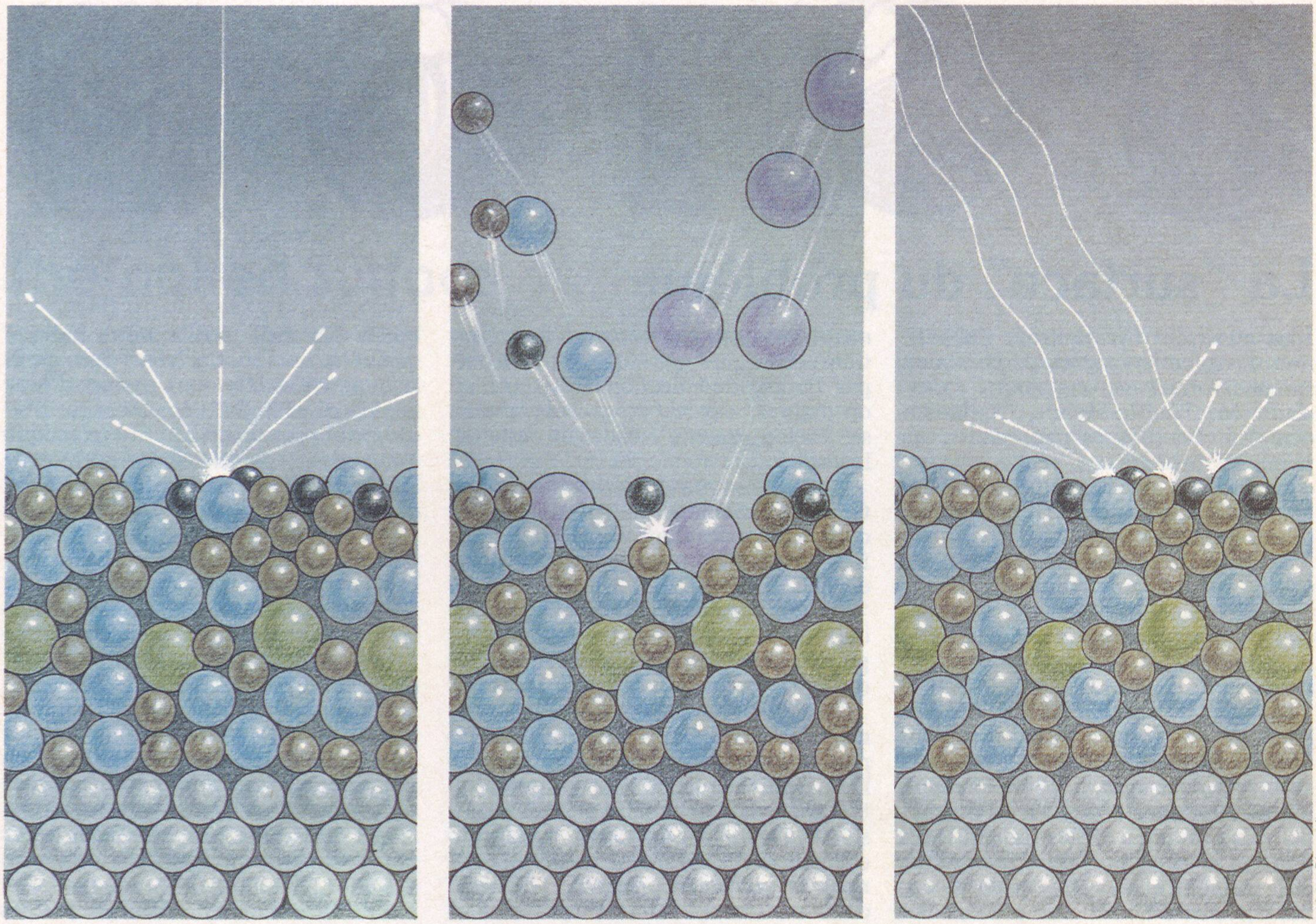

(John Bianchi)

To understand corrosion, scientists examine the chemical nature of metallic surfaces and how the protective oxide films that cover them are changed by outside attack. Three of the analytical techniques commonly employed are shown here. Left: a beam of electrons hits the surface atoms, the ejected electrons are used to identify the elements present. Middle: An Xenon ion beam "sandblasts" the surface atoms, layer by layer. The removed atoms are identified in a mass spectrometer. Right: Low energy X-rays bathe the metal surface, liberating electrons which indicate the material's chemical bonding. Color code: Oxygen — blue; Chlorine —green; Carbon — black; Iron — brown; Xenon —purple.

Pour comprendre le processus de la corrosion, les scientifiques étudient la composition chimique de la surface des métaux et les modifications du film d'oxyde protecteur sous l'action d'agents extérieurs. Trois techniques d'analyse sont illustrées ici. À gauche: un faisceau d'électrons frappe les atomes superficiels, les électrons éjectés permettant d'identifier les éléments présents. Au milieu: un faisceau d'ions xénon "décape" les couches d'atomes superficielles les unes après les autres; les atomes enlevés sont identifiés grâce au spectromètre de masse. À droite: la surface du métal est bombardée par des rayons X de faible énergie; les électrons ainsi libérés fournissent une indication sur la liaison chimique des différents éléments de l'acier. Légende des couleurs: bleu — oxygène; vert — chlore; noir— carbone; brun et gris — fer; violet — xénon.

Graham says. "You'd think that they'd be well understood, but from a fundamental point of view we still don't know how water, for example, affects the top layers." The group's work does, however, indicate that defects such as imperfections or grain boundaries in the oxide and underlying metallic structure cause the protective surface to break down. Generally, following failure, these surfaces are able to repair themselves but, under adverse circumstances, foreign ions, most notably chlorides (found in road salts), appear to become incorporated into the surface film. When this happens the spontaneous repair process is hindered and chemical attack of the underlying metal surface begins.

"Once we can understand all the chemical and physical processes involved," Dr. Graham says, "we'll have a better idea of how to prepare metals to make them more corrosion resistant." In the case of iron-chromium alloys, which are particularly susceptible to attack by sulphur, the NRC research is contributing to the development of methods to improve the performance of these alloys when they are used, for example, in the hostile environment of a sulphur-bearing coal gas atmosphere.

When it is not probing the secrets of surface layers, the "Big Blue Machine" is in heavy demand from industrial laboratories. As a service to industry, Mike Graham's group is involved in looking at problems which range from studies of the effects of fluorides in the waters of Ontario Hydro boilers, the surface impurities in devices for the electronics industry, and the action of catalysts used in chlorine production. In cooperation with the University of Toronto, an investigation is also under way on the embrittlement of steel.

For Mike Graham, the study of surfaces is one of the most exciting fundamental research fields in chemistry today. As he points out, so many important processes take place on surfaces, from biological action in the living cell to chemical catalysis. And for the layman? Well, the "Big Blue Machine" is increasing our understanding of corrosion processes and is paving the way for more effective corrosion prevention in the future.□

David Peat

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