Atmospheric pollution

The veil of two cities

In 1752, Benjamin Franklin sent a metal key on its famous kite flight to demonstrate the electrical nature of lightning. The study of atmospheric electricity subsequently burgeoned, and writing in *Atmospheric Environment* (37, 5319–5324; 2003) R. G. Harrison and K. L. Aplin describe how they have mined records of one aspect of later historical research. They show that electrical measurements made at the Eiffel Tower in the 1890s can be used to estimate the levels of Parisian smoke pollution at that time.

The atmosphere's electrical system results from a combination of thunderstorm activity and the slight ionization of air. The upshot is an electrical potential difference between the ionosphere (at an altitude of some 60 km and more) and the Earth's surface, which causes a small current to flow. The potential gradient close to the ground is an indicator of the electrical state of the atmosphere, and in the nineteenth century it was commonly measured in several European cities.

In clean air, the potential gradient has a distinctive diurnal cycle known as the Carnegie curve. Local aerosol pollution alters this

gradient. So if that effect can be separated from the influence of the global electrical circuit at atmospherically clean sites, it becomes possible to infer pollution levels from potential-gradient measurements. But that is easier said than done.

To analyse electrical measurements made at the top of the Eiffel Tower, Harrison and Aplin applied a relationship between smoke pollution and potential gradient that had emerged from their earlier historical study for Kew, near London, using data from 1863. But they also needed an absolute calibration that was specific for Paris. For this, the authors conducted a modelling study that enabled them to identify the time of day when the top of the Eiffel Tower was in clean air and when it was in the urban boundary layer — the atmospheric layer affected by urban pollution. At times when the tower was in clean air, the observed electrical variations can be attributed to the Carnegie curve alone, allowing an absolute calibration of the electrical data based on the tabulated Carnegie values. At times when it was in the urban boundary

layer, the higher potential gradient signals the presence of smoke pollution.

The approach allowed Harrison and Aplin to estimate smoke pollution at both the top and the bottom of the Eiffel Tower in the 1890s. They calculate that pollution at ground level had an autumnal daily peak of $60 \pm 30 \mu\text{g m}^{-3}$. Their

earlier study gives a value of $170 \pm 50 \mu\text{g m}^{-3}$ for London. In the 1860s the UK Clean Air Act lay almost 100 years in the future. So in the late nineteenth century it is likely that, as a place to live, Paris had the edge over its English counterpart in more than just cancan and cabaret.

Juliane Mössinger

tightly controlled conduit that allows newly made proteins to pass through membranes before the proteins fold into their functional shape.

On page 36 of this issue, van den Berg and colleagues¹³ present the X-ray crystal structure of the translocase (the SecYEF complex) from the single-celled archaeon *Methanococcus jannaschii*, providing an initial view of the atomic architecture of this universally conserved channel. This structure could be considered the latest triumph of genomics, because the choice of the best translocase for structure determination was made on the basis of empirical examination of the expression, purification and crystallization properties of a range of translocases from organisms with fully sequenced genomes.

Almost 30 years ago, as a corollary to his 'signal hypothesis', Günter Blobel^{1,2} proposed that the translocation of proteins across membranes would occur through a proteinaceous channel of the kind now crystallized. Blobel's research at that time had shown that newly made proteins ('preproteins') that are

targeted for export from the cytosol have an extension at one end, called a signal peptide, that is removed during passage through the membrane¹. The hypothesis proposed that different types of extension would function as signals, directing newly made proteins to different membrane-bounded compartments^{1,2}, and the importance of this insight was rapidly accepted. The proposal that protein translocation occurs through a protein channel remained controversial for some time, until later experiments^{3–7,10} confirmed it.

Ion channels have received considerable attention because they show remarkable specificity in allowing one kind of ion through while preventing the passage of very similar molecular species. The protein-translocation channel faces what could be considered a more daunting task, in that it must allow the passage of chemically and sterically varied substrates — representing any segment from a translocating protein — without compromising the permeability barrier of the membrane^{2,4–6,11}. Blobel's original answer to this conundrum was that

translocation would occur at the same time that the protein was being made¹ (co-translationally), with a tight seal between the protein-synthesis machinery (ribosomes) and the pore of the translocation channel maintaining osmotic integrity. But biochemical studies have shown that translocation occurs at least partially post-translationally^{4–7}, and cryo-electron-microscopic studies show a gap of some 15 Å separating the ribosomal exit site from the translocase in detergent-solubilized samples performing co-translational translocation¹⁰ (as in Fig. 1, overleaf). So the pore of the channel seems likely to have variable but controlled conformational properties, expanding just enough to accommodate larger protein segments without compromising the integrity of the osmotic seal.

The crystal structure of the SecYEF channel presented by van den Berg *et al.*¹³ provides an initial atomic-level glimpse of this shape-shifting channel. The authors advance structural arguments to support the hypothesis that the channel's pore is located at the centre of a single SecYEF heterotrimer.