

## The Problem of Subsidence in Salt-Producing Areas

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## ABSTRACT

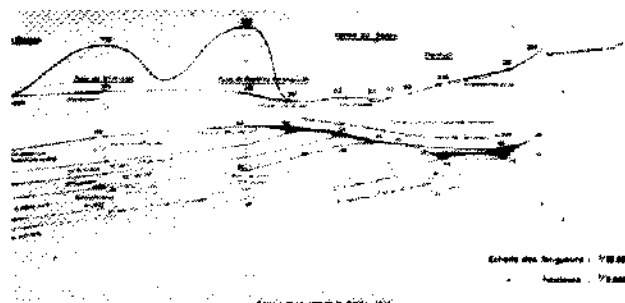
When salt is removed from shallow bedded deposits of geologically recent origin, collapse of the overburden frequently occurs, leading to surface subsidence at sites remote from, and not clearly relatable to the point of extraction. Property damage arising from such subsidence poses legal and physical problems which are dealt with differently in the various areas concerned.

A review of European practices is presented, with particularly detailed reference to those of the United Kingdom in which matters of compensation and restitution have, for many years, been covered by Statutes.

When minerals are removed from the Earth's crust, collapse of the overlying strata and subsidence of the surface is always liable to occur—particularly when the mineral is removed from shallow depths or when the over-burden is structurally weak.

Both conditions are characteristic of many salt-producing areas. Bedded salt formations are frequently covered only by Keuper Marl and drift. This fact, combined with the readily soluble nature of the rock, makes the problem of subsidence due to salt extraction different from that caused by the winning of other minerals. Where the over-lying marl has been cut through by glacial erosion and the valleys thus formed have been filled with drift, surface water and rainfall penetrate to the salt which is then dissolved as the water flows down the contours, with consequent collapse of weak over-lying strata. This effect is particularly marked where pre-glacial folding of the bedded salt, fol-

lowed by erosion, led to out-cropping of the salt. Such conditions are found in the North-West of England and in the Dombasle region of France, which is illustrated in Figure 1.



**Figure 1.**

When a mineral is extracted in solid form by conventional mining methods, the position and extent of the cavity are known with certainty, and any surface subsidence can be directly related to the underground workings. Cases are known in which salt mining has led to clearly relatable subsidence of the surface (Figs. 2 and 3). These figures show the effects of sudden, catastrophic collapse of the roof of a salt mine in Northwich, Cheshire, following the dissolution of supporting pillars by water which entered abandoned mine-workings. Similar phenomena in open country led to the creation of lakes where none had previously existed.

When salt is extracted as brine, it is not known with certainty from whence the salt was dissolved. The surface evidence of solution often appears at points remote from the place from which the brine

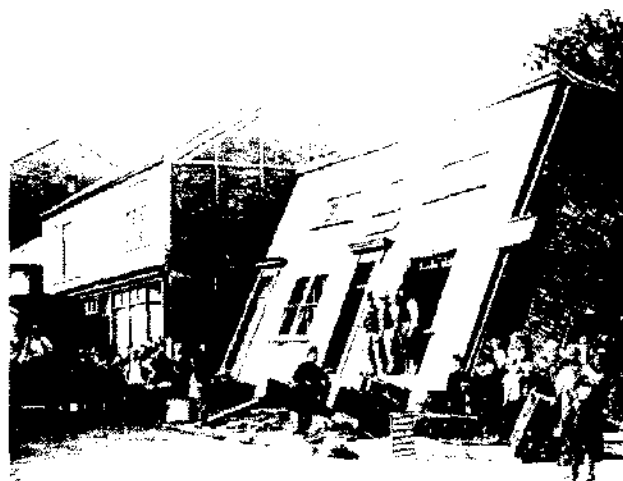


Figure 2.



Figure 3.

emerges—either in natural springs or in the shafts or boreholes from which it is pumped (see Fig. 4). Moreover, it is clear from the occurrence of peat beds in subsidence “valleys” that the dissolution of the salt has been occurring naturally for eons of time, and it is a matter of opinion as to whether the deliberate pumping of natural brine has either caused or accelerated the process. It is therefore clear that subsidence due to salt extraction poses special, if not unique, problems—both technical and legal.

Some two years ago, a survey was made under the aegis of the European Committee for the Study of Salt, to investigate the extent of the problem in those areas of Europe in which salt is extracted by means which might be suspected as giving rise to enhanced subsidence, and to review the legal procedures by which subsidence damage is compen-

sated or minimized. The results may be broadly summarized as follows:

#### FRANCE

Subsidence occurs in Lorraine, in the Keuper series of the Nancy region, around Dombasle. Compensation is dealt with under Article 72 of the Code Minier, and sometimes gives rise to protracted litigation.

#### GERMANY

The problem arises on the Obersalzberg, near Berchtesgaden, and also in the Upper and Lower Necker region, where salt is mined from thick beds in the Limestone series. Compensation is negotiated directly with the mine owner, who is held responsible.

#### HOLLAND

As brine is extracted only by controlled solution, in defined cavities no subsidence problems arise, but paragraph 1401 of the Dutch Civil Responsibility Code makes provision for compensation if cases should ever arise.

#### ITALY

Subsidence does occur to some extent in the Volterra and Lungro districts but is not regarded as a serious problem yet. There is no legal provision for compensation, which is the subject of private agreement with the complainant.

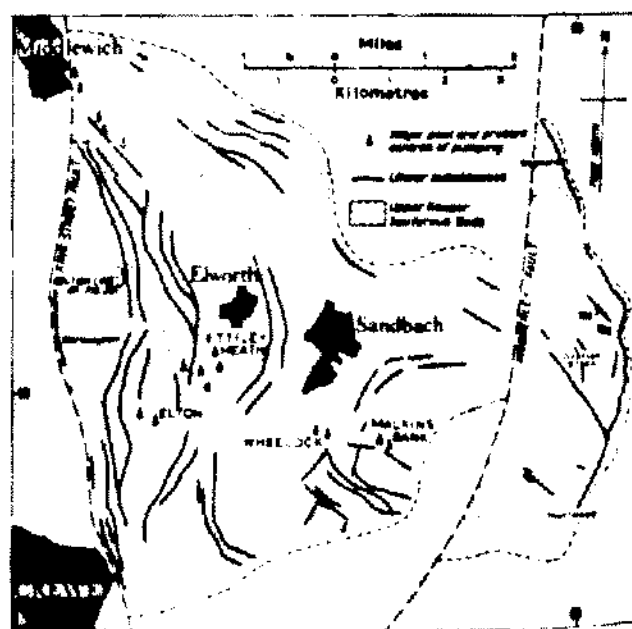


Figure 4. Distribution of major linear subsidences resulting from solution of the Upper Keuper Saliferous beds.

## SWITZERLAND

Subsidence occurs only in the Schweizerhalle region and compensation is covered by Cantonal law and the Civil Code on Vicinity rights.

## UNITED KINGDOM

Subsidence (on a scale much less than that which occurred at the end of the last century) occurs in parts of Cheshire, Staffordshire and Worcestershire. It is most widespread in Cheshire, where Acts of Parliament have ensured the compensation of private property owners since 28th July, 1891. Agitation from property owners started in 1871. The current legislation is the Cheshire Brine Pumping (Compensation for Subsidence) Acts of 1952 and 1964, the workings of which are described in more detail later.

*Published information on subsidence problems.*

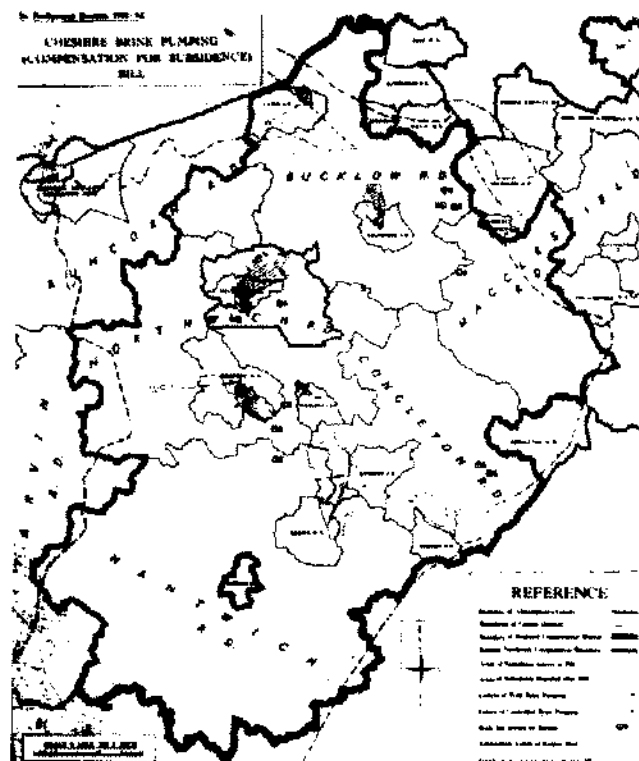
In the last few decades, a number of papers have been published on subsidence problems—their cause and avoidance, and the minimization of consequent property damage. Many of the papers on the latter subject refer to subsidence caused by conventional mining operations for coal and minerals of all sorts, but the information and advice given is equally applicable to structures built in areas subject to subsidence caused by the leaching of salt beds lying near the surface.

In this connection, it is of interest to observe that similar traditional structural designs have been evolved over the centuries in widely separated areas of Europe subject to subsidence. The characteristic feature, shown by houses built 400 or more years ago, is the use of framing, not only above ground but also in the foundation. The resultant structure is essentially a box which can and does tilt when the ground beneath it settles irregularly and the integrity of the structure is thereby preserved. Structural designs currently recommended incorporate the same principle.

On the legal aspects of compensation for subsidence damage and the technical aspects of defensive and corrective measures, British law and practice are highly developed and are illustrated by the working of the "Cheshire Brine Subsidence Compensation Board."

The Cheshire Brine Pumping (Compensation for Subsidence) Act 1952, covers the following principle points:—

1. The Act covers a defined area of Cheshire only. Figure 5.
2. A Compensation Fund is established and fed by levies (based on quantity extracted) on all Brine



**Figure 5.**

Pumpers; natural brine pumpers pay three times as much per unit volume of brine pumped as those who practice controlled solution.

3. The Fund is administered by a Board (which meets monthly) consisting of fifteen members who represent, in equal numbers, the Brine Pumpers, the Cheshire County Council and Local Authorities in the areas concerned.
4. Private property owners (Public Undertakings are debarred from claiming) alleging damage due to subsidence, give notice in a prescribed manner within six months of damage becoming apparent.
5. If the Board, on the basis of reports by its Surveyors, confirms that the damage was caused by subsidence, compensation is awarded on the basis of adjudicated claims for the incurred costs of repair or renewal.
6. Continuing claims can be commuted for a lump sum payment.
7. The Board may make recommendations regarding the design of new property to be built in the compensation district, so as to minimize damage due to subsidence and facilitate its correction. In such cases, financial assistance for the extra cost may be granted by the Board.

Examples of the special structural precautions are shown in Figures 6, 7 and 8. These represent a



Figure 6.

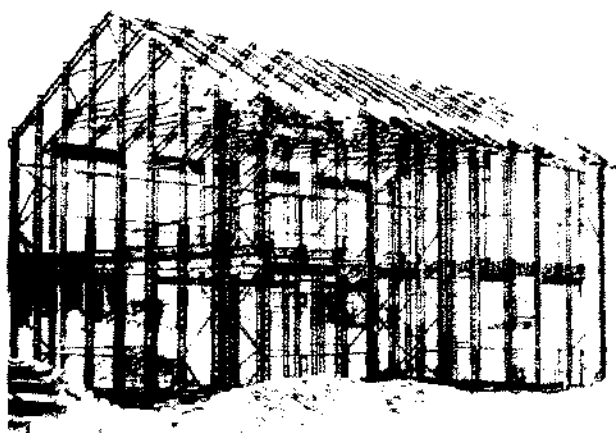


Figure 7.

considerable improvement on the older methods, which are pictured in Figures 9 and 10.

This system has worked well for many years, and has given satisfaction to most owners who have suffered damage, and at an acceptable cost to the Salt Manufacturers.

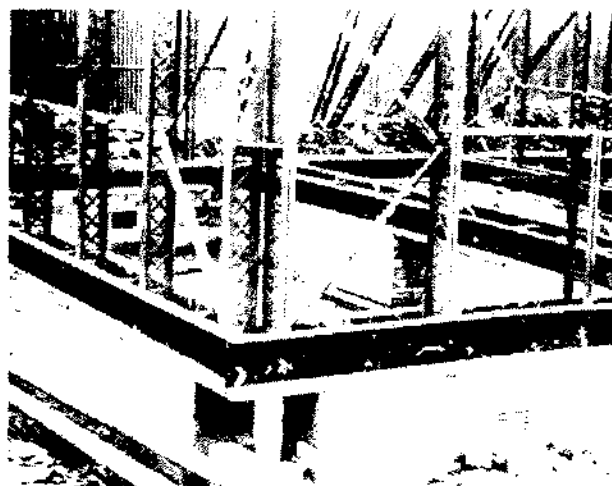


Figure 8.



Figure 9.

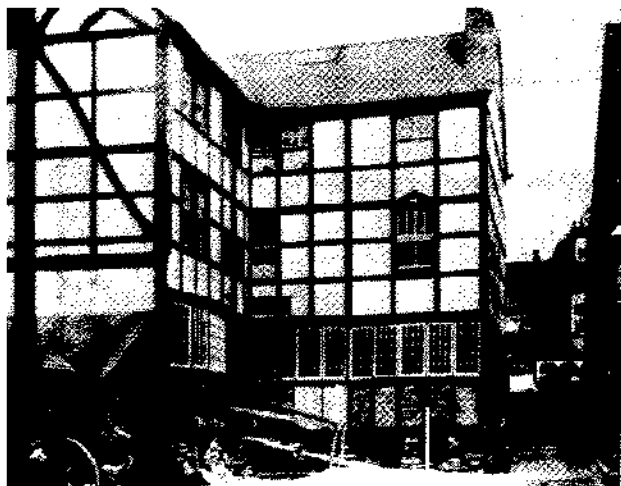


Figure 10.

### ACKNOWLEDGEMENTS

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*Figure 4* is a Crown Copyright Geological Survey Diagram and is reproduced by permission of the Controller H.M. Stationery Office.