

病害状况与成因

Condition and Causes of Deterioration

壁画病害包括盐害、起甲、地仗层与砂砾岩层之间失去粘结力后造成的空鼓脱落等。后者为最严重的病害。在85窟发现大量的壁画空鼓有脱落的危险。最近一次壁画脱落发生在1996年，有一大片壁画从主室西披脱落。

The paintings suffered from salt deterioration, flaking, and loss of adhesion between the conglomerate rock and the earthen plaster. The latter problem was the most serious, as substantial areas of the painted plaster were found to be detached and susceptible to collapse. Most recently, a large piece of painted plaster fell from the west slope in 1996.



85窟后部区域盐害造成颜料层的点状脱落。
Salt deterioration is the cause of the small point-like losses in the paint layer in areas toward the back of the cave.



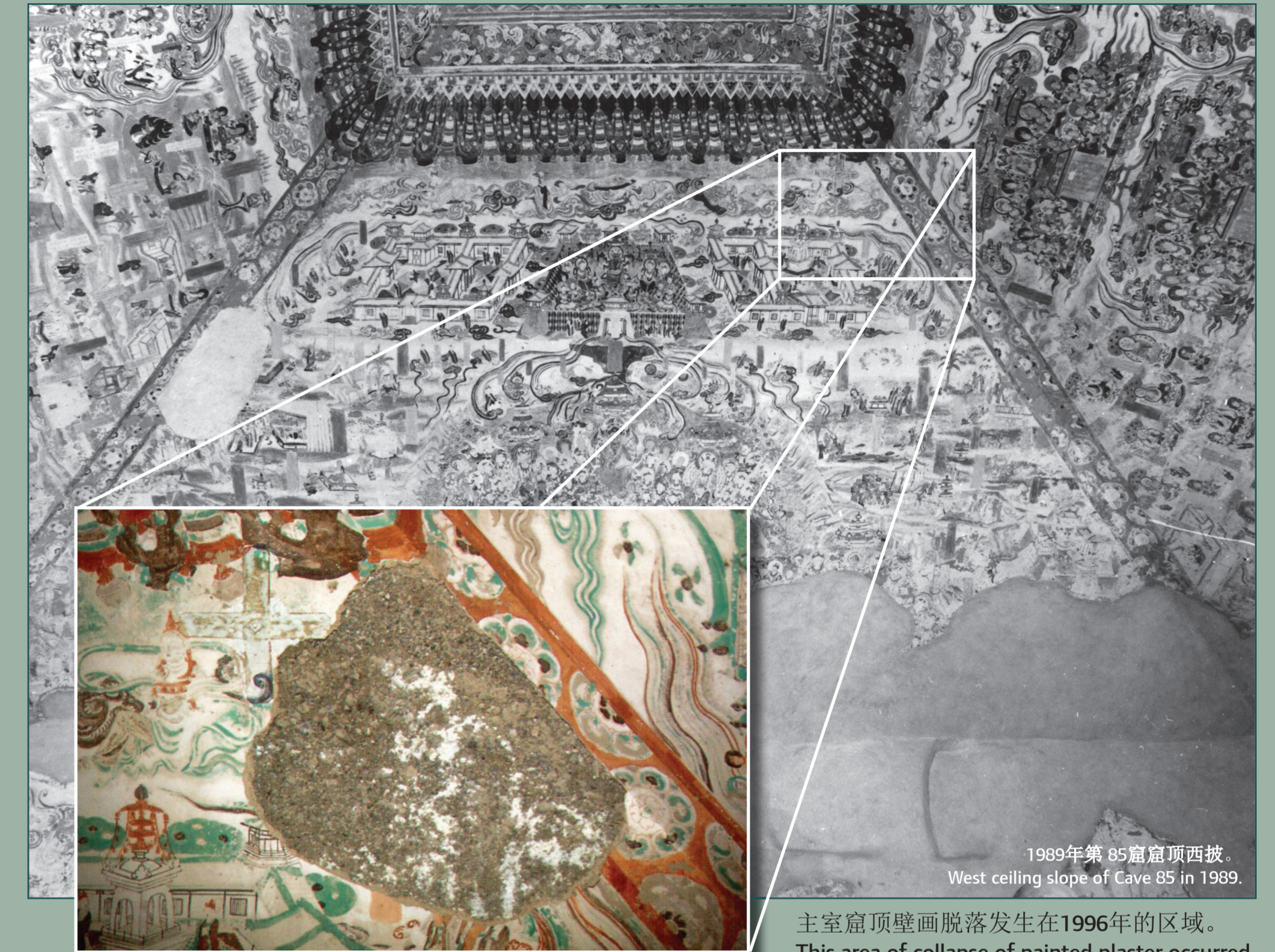
颜料层起甲与酥碱起甲。
Flaking and exfoliation of the paint layer.



20世纪70年代，为防止壁画脱落进行了壁画锚固。上图显示仍然保留在主室北壁的锚固与垫板。
Anchors and bolts were inserted into the walls in the 1970's to secure areas of detachment. The anchor shown above was left in place on the north wall of the main chamber.



锚固只是用来对付壁画仍然继续脱落的一个权宜之计。1996年的残片脱落是在一段时间的高湿度之后发生的。
The anchors were only a temporary solution as areas of painted plaster continued to be lost. These fragments fell in 1996 after a period of high humidity.



1989年第85窟窟顶西披。
West ceiling slope of Cave 85 in 1989.
主室窟顶壁画脱落发生在1996年的区域。
This area of collapse of painted plaster occurred on the ceiling of the main chamber in 1996.

病害调查与诊断

Investigation and Diagnosis

对以前壁画处理与状况的记录和历史照片进行了研究。病害趋势显示，此窟壁画病害自东向西加重，洞窟后部（西部）的病害最严重。合作组对壁画的病害成因、病害机理以及劣化速度进行了调查与诊断。

Study of historic photographs, recording of previous treatment and condition were undertaken. Patterns of deterioration showed an east-west distribution with condition worsening toward the rear (west end) of the cave. The causes, activation mechanisms, and rates of deterioration of the wall paintings were then investigated and diagnosed.



20世纪60年代第85窟的外景。
Exterior of Cave 85 in the 1960s.

莫高窟在被废弃后的数百年里，洞窟一直暴露在外，崖面风化、风沙和水的侵蚀是壁画和塑像产生病害的主要原因。The cave was open to the exterior for many centuries after the abandonment of the site. Erosion of the cliff face, windblown sand and water were responsible for much of the deterioration of the cave wall paintings and sculpture.

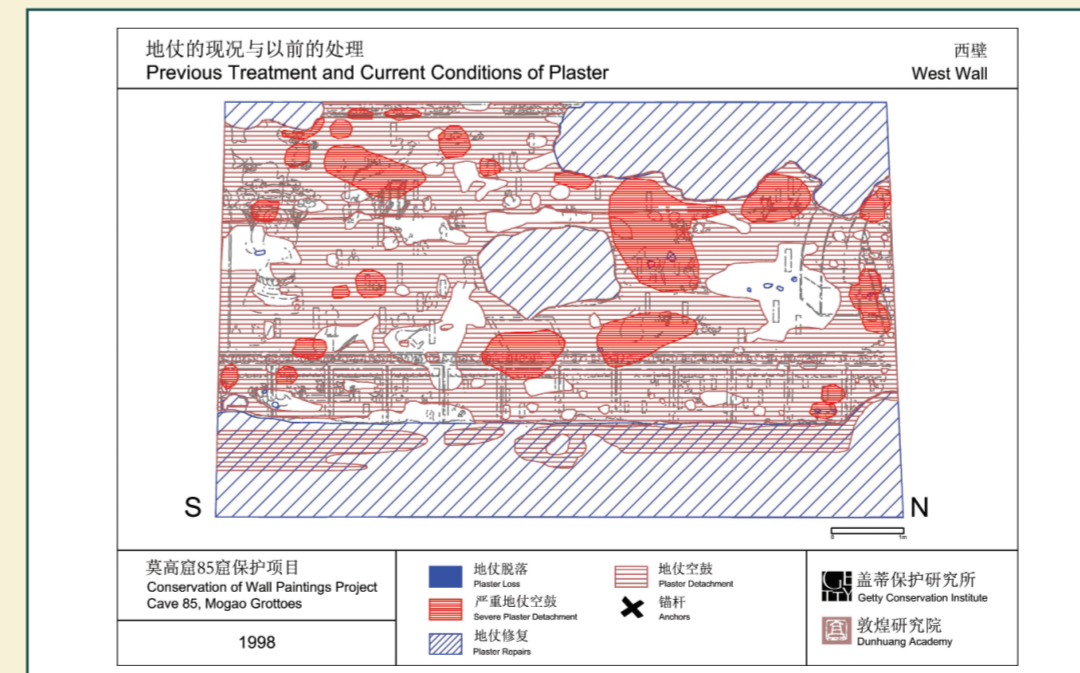


20世纪40年代第85窟内景（图版：罗寄梅所摄）。
Interior of Cave 85 in the 1940s (Image: Luo Jimei Archive).

壁画大量脱落是由于四壁下部遭到湿气侵入及上层地仗层的坍塌。The paintings have suffered large losses at the base of all walls from moisture ingress and collapse of upper areas of plaster.



85窟病害分布3维模型显示了85窟的病害模式。壁画脱落区域（黄色）集中于四壁下部和后部，窟顶角落；壁画空鼓区域（红色）在整个窟都有发现，但主要集中于石窟后部。
A 3D cave model shows patterns of deterioration found throughout the cave. Areas of loss of painted plaster (yellow) were concentrated at the base of walls and toward the rear, upper corners of the cave; areas of detachment (red) were found throughout but were also concentrated toward the back of the cave.



图解形式显示85窟以前的处理与状况。图例是西壁病害状况图。蓝色阴影部分为脱落区域，红色部分为大面积地仗层空鼓。
Records of previous treatment and condition were graphically displayed. This example of the west wall shows areas of loss (blue hatching) and large areas of plaster detachment (red).

病害成因

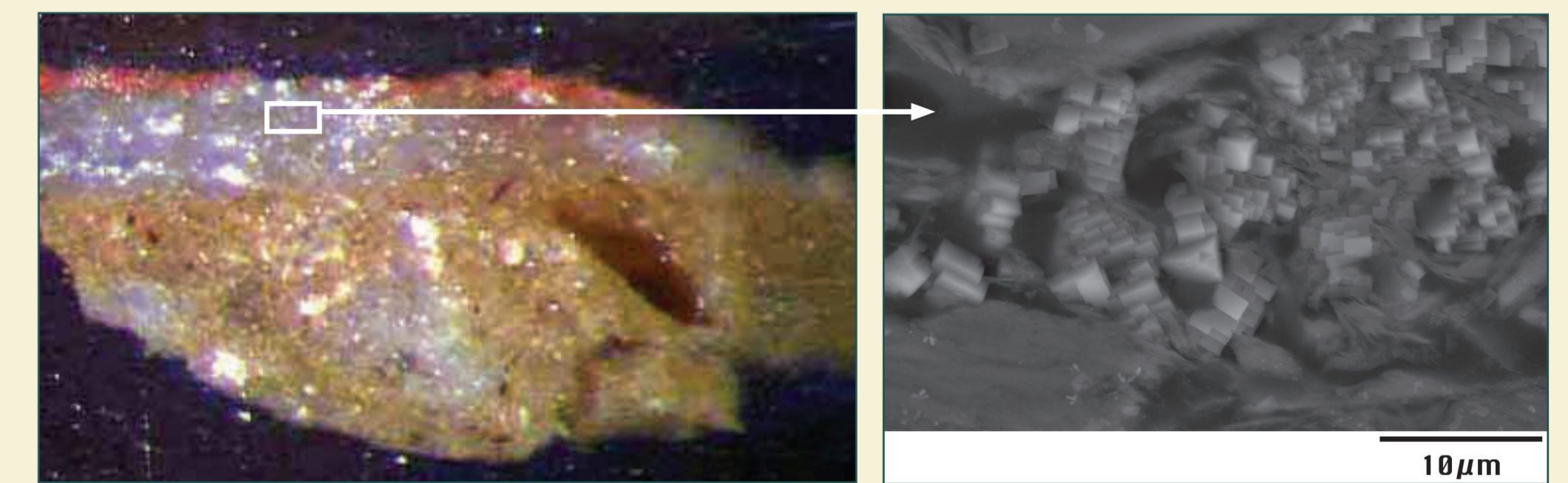
Causes of Deterioration

过去洞窟内病害的原因有立即性的与逐渐性的：湿气侵入四壁下部导致原来材料发生物理化学性变化以及盐份的活动导致病害发生。我们可以减低大部分的病害原因，但是无法移除壁画中的所有盐份。因此，了解盐害发生的过程，制订预防性与保护性的措施，是降低病害发展速度的基本手段。

Past causes of deterioration in the cave have been both immediate and gradual: moisture ingress at the base of walls, physicochemical changes of the original materials, and deterioration caused by salts. We can reduce most of these causes, however, we cannot remove all of the salts present in the painted plaster. Therefore, understanding the processes of salt deterioration was the basis for developing conservation and preventive measures to slow the rate of deterioration.



项目开始时进行的状况调查记录。
Condition recording was undertaken at the start of the project.



壁画层的剖面图（左上）和高倍放大的氯化钠（普通食盐）的晶体推挤颜料层（右上）。盐是大部分病害的主要原因，诸如造成颜料层脱落、地仗层酥碱以及壁画空鼓等。
A cross-section of painted plaster (above, left) and a highly magnified image of NaCl (ordinary table salt) crystals pushing through the paint layer (above, right). Salt is responsible for much of the deterioration such as loss of the paint layer, disruption of the plaster, as well as contributing to detachment of the painted plaster.