MINING.

FAULTING IN VEINS.

BY JOHN A. CHURCH.

Editor Engineering and Mining Journal: SIR,—In the *Engineering and Mining Journal* of April 9th Mr. Albert Williams, jr., suggests that "a large proportion of veins are on the lines of *fault* fissures," and he uses the word "fault" in its true sense, meaning a crevice, the walls of which have moved upon each other. In support of this proposition he makes two assertions: 1st. Veins are more regular in their dip than on their strike, which indicates a downward shearing action and thus becomes a proof of faulting; 2d, smooth walls, slickensides and clay selvages are proof that the walls have rubbed on each other and he likens the walls to "two slabs which the stone dresser is surfacing."

I do not intend to discuss the first of these opinions at present further than to say that his evidence is faulty in one respect. There are veins that are fairly regular in their dip, others that are very irregular, not only changing the degree but even the direction of their dip. When there are several sharp changes in the angle of dip, or when there is a reversal of dip, the walls are so interlocked that up and down movement on each other must be impossible. I have lately examined a mine in which the vein beginning near the surface with a dip, say, of 45 degrees, gradually increased to verticality, and then passed over to a dip in the opposite direction. If the dip were regular, the profile of the vein might be called circular, but this regular increase of dip was accompanied by pronounced local irregularities, amounting in one place to absolute horizontality for a considerable distance. It seems to be impossible for such interlocked walls to move on each other without shearing off the projecting bosses or dislocating the moving wall at re-entrant angles.

With all our observation of veins such results of motion have not often been pointed out, and therefore we must acknowledge that one important and obvious proof of motion is absent. Mr. Williams fails to show that the veins with regular dip present any phenomena different from those in veins of irregular dip, and until this is done I doubt if mere regularity of dip can be accepted as a proof of faulting.

However, it is his second proposition that I propose to discuss: Are smooth walls, slickensides and clay selvages proof of rubbing motion? In denying this assertion I am not attacking views peculiar to Mr. Williams They are so commonly found in mining literature that I suppose there is no belief more general. Mr. Williams has merely given the latest expression to the received opinion on the subject, and he represents it accurately, for he supposes slickensides to have been formed by the extremely slow motion of rock surfaces upon each other under powerful pressure.

It is to be remembered that veins are not the only form of crevices known. Bedding planes between rock strata are found in much greater number than veins. These sedimentary rocks, once horizontal, have been lifted into all degrees of dip up to verticality. They have been bent, twisted and shoved and always under powerful pressure. Their surfaces must have been rubbed on each other. Why do we not find slickensides in them? The common impression is that the movement in vein walls has been recurrent, but there is just as much proof that it has been recurrent in beds.

The assumption that slickensides are surfaces rubbed to a polish by the movement of vein walls had its origin in the early years of geological study when violent movements were believed in. Violence and rapidity of dynamic action have been superseded in great measure by the slow continuous action through long periods of time, which is usually accepted now as the method of geological changes. It was easy to understand how rapid movement could polish, for that is the method of artificial polishing to this day, but no one has given the least proof that the slow movement which the rocks are supposed to have had could produce a polish. Imagine a bootblack whose brush moved an inch a century! Would he get a "shine" in ten million years?

I examined recently a gold mine in which the vein, 2 to 3 ft. thick, was over large areas entirely composed of slickensided slabs of quartz. If the hanging wall were removed the quartz could be pried out with a crowbar and slabs produced from 1 to 6 in. thick, with slickensides on both faces. If these had been flat slabs I suppose it would be suggested that they were marked by being rubbed against each other, but they were irregular in thickness and resembled figs that have been pressed into a box. Their irregularities were so great that they could not have been rubbed on each other without forcing the walls apart. The case was further interesting because there was no polish, the surfaces being formed of striations, but otherwise "dead" or unpolished. There were isolated cases of polishing, and there were also parts of the vein which seemed to be solid and not formed of striated slabs; but they were exceptions. Taking that vein as it exists to-day I venture to assert that no movement, either slow or rapid, exerted now, could continue the work of striating these slabs or move them upon each other.

My attention was directed to slickensides many years ago by a specimen of quartz which had two areas of markings on its face. The markings were deep, and so placed, nearly at right angles, that the rubbing surface which matched this piece could not have been moved in any direction without obliterating one or both of the markings. The two sets of markings could not have been made at the same time, for if so they proved it was motion in two contrary directions at once. Nor could one have been made after the other without destroying the first. I was convinced that these marks were made by some other means than rubbing.

In the Comstock the great bodies of quartz are intersected by layers of clay which have been referred, like other vein clays, to the results of rubbing. Originally they were layers of the eruptive rock in which the quartz