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RICKFORD AND LANGFORD RESURGENCES, MENDIP HILLS, SOMERSET, A PROBLEM IN LIMESTONE HYDROLOGY

By

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ABSTRACT

Conflicting views have been expressed about the hydrology of the catchment area to the east and west of Burrington Combe, mainly over the separation of the areas draining to Rickford and Langford resurgences and the amount of swallet water resurging at these two sites. The results of water tracing are examined and the discrepancies clarified by results from chemical analysis of water samples and hydrological analysis of flow records.

While the attention of many geomorphologists and spelaeologists may focus, in the Burrington area, on the Combe and its caves, the hydrology of the area has proved a complex and controversial topic. Tratman (1963) described the area and traced the major swallets which drain water from the north flank of Blackdown. Drew, Newson and Smith (1968) also did water tracing in the area, using the spores of Lycopodium—in contrast to the Fluorescein used by Tratman. For a specific study of limestone erosion Smith and Mead (1962) used the resurgences at Rickford and Langford as sampling points. More recently the author, (Newson, 1970) has collected data on both solutional and mechanical erosion from the swallets and resurgences. The present paper is based on that work and attempts to explain differences in the findings of the papers referred to above.

Smith and Mead (1962) sampled water at Rickford and Langford resurgences and plotted its hardness values (dissolved calcium carbonate) against discharge figures kindly supplied, as in this study, by Bristol Waterworks Company, from their gauges at the two sites. Both are sharp-crested rectangular weirs, rated theoretically and continuously recorded on flow charts. Daily mean discharge at Rickford averages 0.16 cumecs while at Langford it is 0.08 cumecs. Smith and Mead's results show (their Fig. 49) that the two resurgences exhibit very different chemical response to high discharges. Langford's hardness falls steeply during the passage of a flood, whereas Rickford's shows little, if any, change. It is important to remember here that the two authors' sampling was irregular and not intensive. Their conclusions are that, although Langford and Rickford resurgences appear to be fed by 'stream' (the present author prefers 'swallet') water and percolation water respectively there is not enough difference in the response of their flow to rainfall to support this conclusion.

Tratman's water tracing produced positive traces from the swallets to Langford only, fluorescein from East and West Twin-streams and from Bath Swallet being recorded visually at that resurgence. He was not able to obtain positive traces for the Hunters Brook. Never was dye seen to reach Rickford though a close watch was kept. However, Tratman does not discount a very rapid transmission of dyed water to Rickford.

Drew, Newson and Smith (1968) used a more reliable method by introducing, simultaneously, variously dyed spores of Lycopodium (Drew and Smith, 1969) to four swallets, Ellick Farm, East Twin, West Twin and Hunters Brook. As can be seen from Fig. 29, positive traces were obtained at both Rickford and Langford resurgences and, on the basis of the velocity of travel and abundance of spores collected they described Rickford as, 'the more maturely developed rising and a major outlet for the waters of the area'.

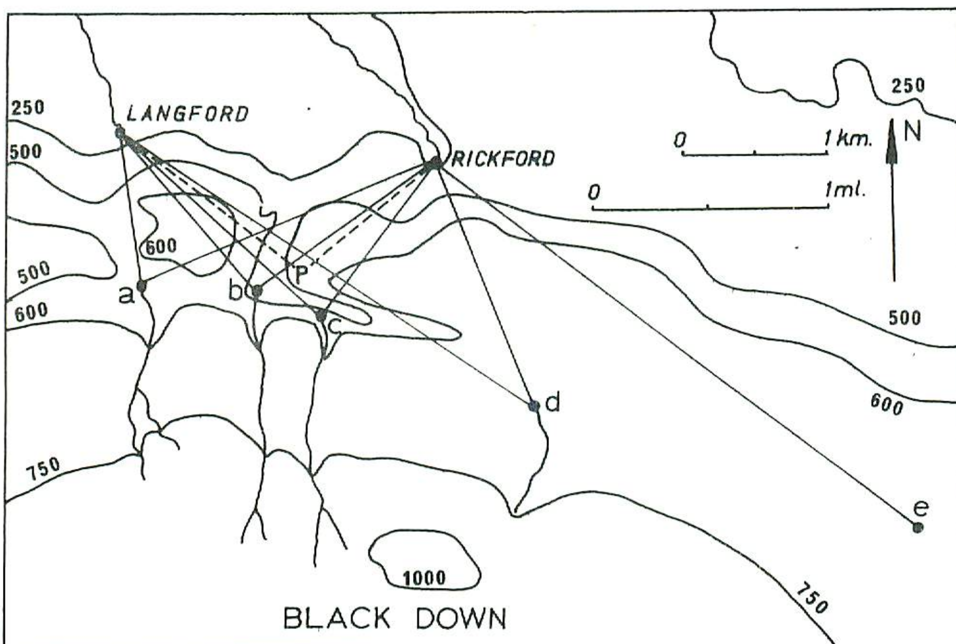

Fig. 29. Water tracing connections between Blackdown swallets and the resurgences at Rickford and Langford (after Drew, Newson and Smith).
Key to swallets: a—Reads Cavern (Hunters Brook)
b—West Twin Brook
c—East Twin Brook
d—Ellick Farm stream
e—Ubley Hill Pot (underground streamway)
P—Percolation trace from surface of Burrington Ham

No further swallet water tracing has been done by the present author. However, during an intensive study of the area in 1968 and 1969 a series of techniques were developed whose use throws some light on the apparent discrepancies outlined above. Firstly streamflow measurements have been extended, by gauging of the swallets (Hunters Brook, West Twin, East Twin and Ellick) using 'V' notch weirs. Chemical analyses of the type used by Smith and Mead were made at both swallet and resurgence sites but a more intensive sampling programme was followed. Sediment samples were also taken from a variety of stream sites.

It was Tratman (1963) who first pointed out that 90 to 95 per cent. of the water resurging at Rickford and Langford was of a percolation origin. This enters the limestone via the soil and is, in most cases, subject to storage both in the soil and in the limestone. Because of its generally slow flow and lengthy residence time in the limestone it is of high and relatively constant hardness. In contrast, swallet water is more rapid, more variable and more dilute. The great difference in the response to rainfall of both systems and their characteristic chemistry allows them to be separated during the passage of a flood by a combination of hydrological and chemical methods. In some cases, of course, the percolation system is atypical and in a limestone with little soil and wide joints percolation water may respond as rapidly as swallet water to rainfall, becoming equally dilute in dissolved limestone. This is not likely on Mendip, except in the case of widespread surface depressions, which focus percolation into large, integrated flows, (Newson, 1970). So far on Mendip percolation water has been shown to have typically slow flow through times, for example, 10 to 12 days from Burrington Ham to Rickford and Langford and 3 days from the surface above East Twin cave into the main chamber (less than 10m. below).

Two floods were monitored, one in March 1969 at Rickford and another in July of the same year at Langford. Individual measurements during other floods suggest that the two chosen were in all ways typical. The major point of interest is that there is a detectable dilution of hardness at Rickford in flood. Since the total hardness analysis was done as a check the changes noted can be taken as significant, being outside the standard error of that method. However, as can be seen, the reduction of hardness which accompanies the flood is hardly comparable with that which occurs at Langford. As a further check, and as a key to the source of the water the collection of two samples allowed calculation (using the double titration method of Stenner, 1969) of the aggressiveness of the water to limestone. Swallet water is usually capable of dissolving limestone when it enters the underground system, whereas percolation water is typically saturated with it. The fact that the slight dilution at Rickford is accompanied by a change from saturated to aggressive conditions, together with the fact that the change coincides with the peak of swallet flow, signifies that swallet water is indeed arriving rapidly at the resurgence, though in small volumes. In contrast, the more extreme changes at Langford are most likely the result of the arrival of more significant volumes of swallet water.

By calculating the total swallet flow into the underground system, in the area as a percentage of resurgence outflow a straight-line relationship can be established between hydrological and chemical conditions at the two resurgences (Fig. 30). Where percolation and swallet water are of different chemical properties such relationships can be used to indicate

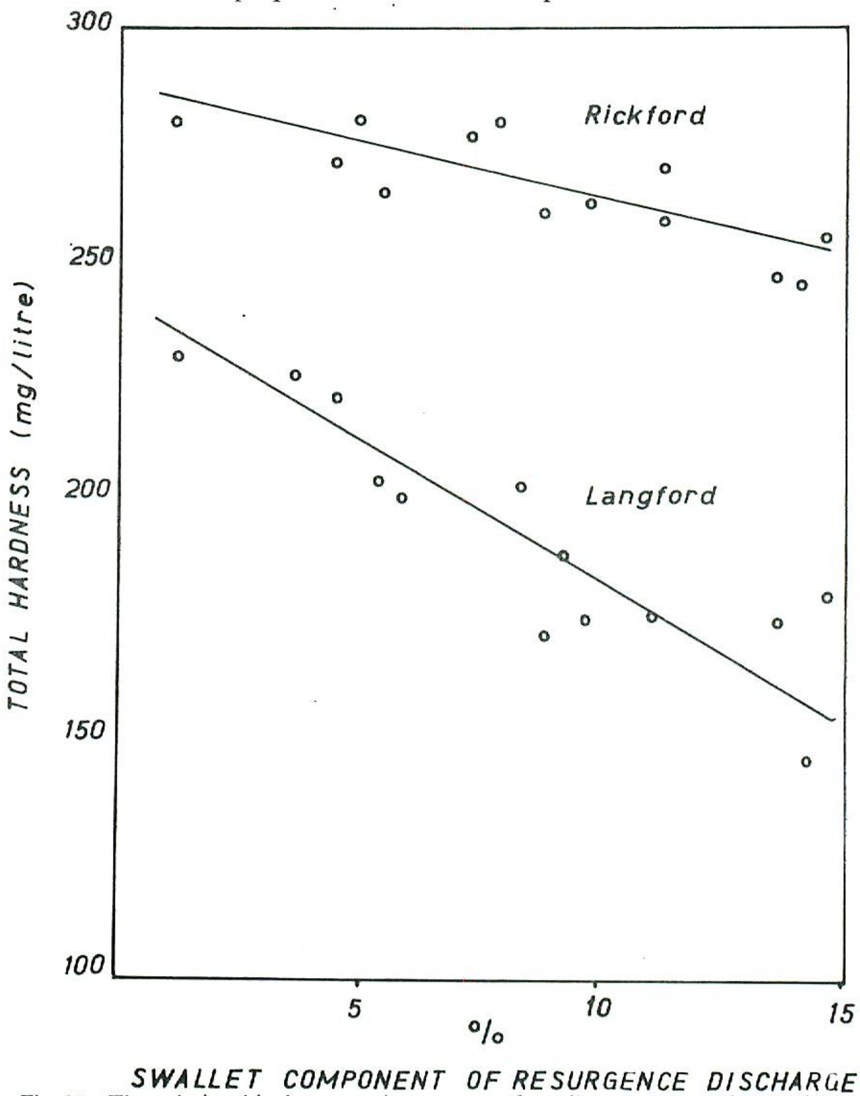

Fig. 30. The relationship between the amount of swallet water reaching Rickford and Langford resurgences and their hardness. Flow components derived by simultaneous gauging of swallets and resurgences.

water flow lines; the site with the steepest decline in hardness with increasing discharge can be predicted as the outlet for more of the swallet water. In this case it is Langford. Smith and Mead came to this conclusion but took it no further because they said that Rickford's hydrograph was not significantly slower to respond to fainfall than Langford's, although one would expect a percolation-fed outflow to show very few sharp peaks in outflow. It is also the conclusion from Tratman's water tracing that Langford is fed by swallets.

The present author has investigated a series of flood events at Rickford and Langford resurgences. As revealed by the calculation of the statistical return period of flooding of a certain volume (Hanwell and Newson 1970), Langford floods more frequently than Rickford. Langford has experienced four flows larger than its peak of July 1968, whilst Rickford's record over the same period, with the same rainfall, shows none higher. Inspection of individual flood hydrographs shows that Rickford and Langford reach their peak flow roughly simultaneously on most occasions. There are almost an equal number of occasions on which Rickford or Langford reach their peak flow before the other. Subjectively, the variation appears to be due to the rainfall conditions prior to the flood. After dry weather Langford rises more rapidly than Rickford. Thus Smith and Mead's conclusions about the similarity of flow are not completely justified. The return of Rickford to base flow conditions after a flood tends to be slower than Langford, this being concommittant with a flow largely derived from percolation. The more extensive storage capacity of the Rickford system is also evinced by the fact that, unlike Langford it does not dry up completely. The flow duration curves shown in Fig. 31 makes it clear that Langford has the more 'flashy' regime, although the difference is slight. It is observable on the curves that moderate flows, in the order of one quarter of the peak, occur nearly 20 per cent. of the time at Rickford but under 10 per cent. of the time at Langford. Since the curves are based on 15 years of records, the conclusion that Rickford's regime is more typically that of a dominantly percolation source is more reliable than the similar one drawn from inspection of a few individual hydrographs. Matched with the chemical evidence they reveal the dangers of interpretations from water tracing results alone.

Two further points remain to be clarified. Firstly, why did Drew, Newson and Smith (1968) obtain rapid and abundant transmission of spores to Rickford from the four swallets tested? Secondly, how do differences in source of flow tie up with sediment studies at the resurgences? Some light has been thrown upon the fast flow times recorded for Rickford by correspondence in the Wessex Cave Club Journal. Stanton (1969), declaring a 'hosepipe hypothesis' suggests that a very small passage, or series of such passages, linking the Blackdown swallets with Rickford, could transmit large numbers of spores more rapidly than a

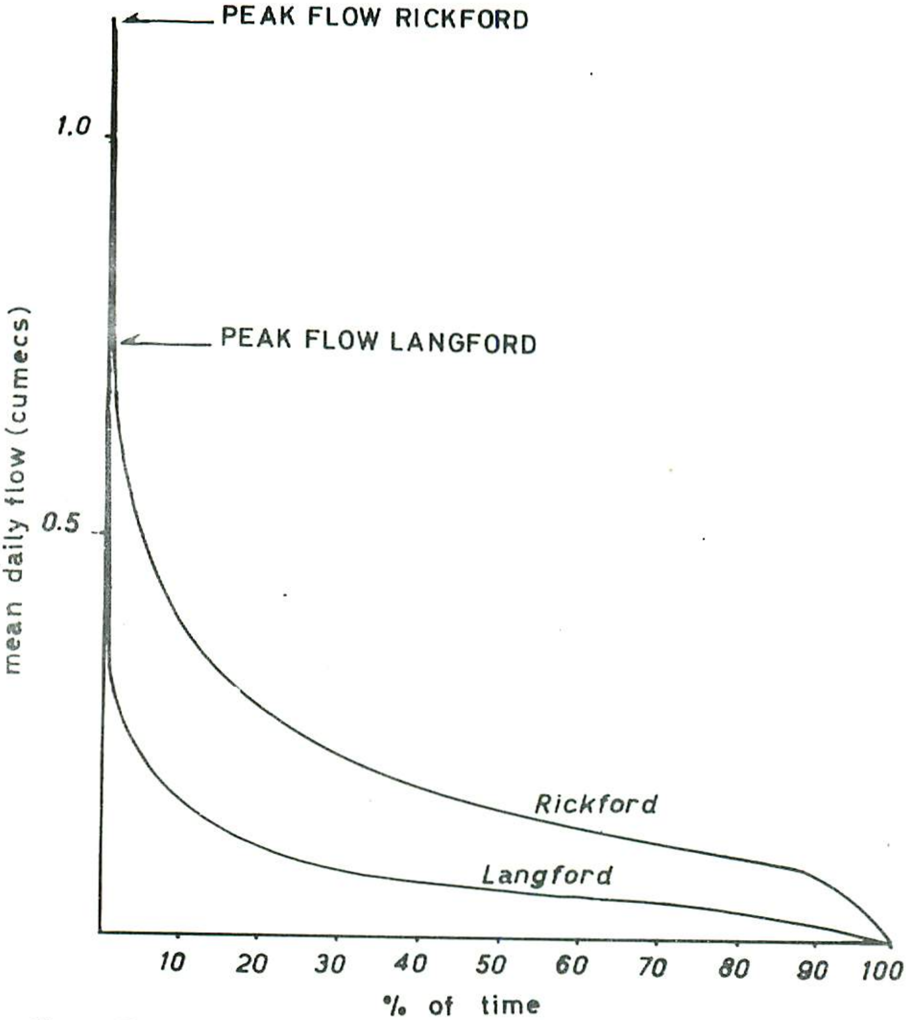

Fig. 31. Flow duration curves (based on daily mean flows) for Rickford and Langford resurgences.

fully developed cave passage with pools and pots. This may be a good reason for the response to rainfall of Rickford which, as mentioned, is often atypically rapid for a resurgence whose swallet component is arguably small. Percolation water may also respond rapidly along certain routes (e.g. from Ubley Hill Pot in Drew, Newson and Smith's trace) while in others it is delayed (e.g. from Burrington Ham).

The results of sediment analysis show that volumes in suspension are about equal at the resurgences and both discharge swallet-derived material. However, detailed analysis of the very turbid flows which existed some time after the 1968 and 1969 summer floods at Rickford prove the size of material to be exceptionally fine; it remained in suspension across Rickford Pond and was still a problem of water engineers at Barrow Treatment works where Rickford water is processed before supply to Bristol, as is Langford's. Such a fine calibre of sediment, and its red colour would seem to suggest the collapse of cave earth rather than the washing through of typical swallet-derived material.

To conclude, it must be stated that the problem of describing separate hydrological identity for the two resurgences has by no means been solved. It is clear that they must have, to some extent a joint catchment. It has been pointed out to the author that a possible conclusion from the evidence for this overlap could also be the existence of a piezometric surface. However this does not agree with the chemical evidence, nor with the very low flows at Langford, some 10 m. lower in altitude than Rickford. The difficulty in separating two distinct catchments for the resurgence is far more likely to be due to geological structure. The steeply-dipping Carboniferous Limestone in the area is likely to have a large number of solutional openings along the strike at a variety of levels. This is demonstrated by the abandoned caves in Burrington Combe and the Twin valleys.

Rickford has the larger share of the catchment, stretching some distance to the east, from whence it derives percolation water. The Langford catchment overlaps this but consists mainly of the area occupied by the Blackdown swallets. Though it has been hinted (Drew, Newson and Smith 1968) that the shared catchment could mean that capture is occurring there is no evidence of this from the last 40 years of discharge measurements. The ratio of 2 : 1 as Rickford : Langford (on an annual basis) seems stable.

It may be, however, that Rickford resurgence has changed more dramatically than Langford during the period since the last glaciation. The lower part of Rickford Combe, above the present resurgence, has some of the appearances of a valley formed by spring sapping and Squire's Well Rising, near the head of this part of the combe, and which now only discharges in very wet conditions, could well have been one of a series of precursors to Rickford. Langford resurgence is not associated with a large dry valley and does not discharge at higher levels in flood. The glacial history of the area is at present being re-examined (Hawkins and Kellaway 1971) and Donovan (1969) presents the evidence for a glacial origin for most of Rickford Combe. Until further work appears the geomorphological implications of present-day hydrology must remain in question.

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