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Software Engineering in a 3-D Virtual Environment

Final Report for McNair

Raymond Skroback, Scholar

Dr. David Fleming, Mentor

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For the most part, today's software is created by typing in several to several million lines of code. Although modern software development tools provide many forms of "drag-n-drop" support, the core of most all software developed is still text-based. This project examines an alternative software development method, wherein software is viewed not so much as a bunch of text, but instead as *virtual hardware*; i.e. software is viewed as if it were machinery in a three-dimensional virtual-world. This approach is much more intuitive than text-based programming. Moreover, this view of software offers hope that traditional engineering paradigms can more readily be applied to the software engineering process.

Before one can understand how this *virtual hardware* view of programming is truly a better system than what we have currently, one must examine the methods of programming from the past and now in the present.

In the past, computers and programming were radically different than what we see here in modern times. Computers were as large as entire rooms and literally took a more physical program in the forms of paper-tape and punch-cards. Paper-tape was a spool of paper approximately one inch wide in which the programmer would punch a series of holes. The spool of tape was then fed into the computer which interpreted the series of punched-out holes as a computer program. Punch-cards were metal trays that resembled circuit boards. The programmer would connect wires to the card at various points (the

end-result usually ended up looking like an old-fashioned operator's switch board). This was in turn plugged into the computer which interpreted the alignment of the connections as a program.

Modern day programs are much more recognizable to the layperson. The stereotypical programmer sits in front of a computer screen, fingers buzzing away at the keyboard typing in multiple lines of text that seem to make little or no sense upon first glance. This is not far from the truth. Text-based programming is the norm today, programs can be anywhere from a couple to several million lines of text. The computer then interprets that text as the program and runs it accordingly. This is not the ideal method of programming however. Simple typos can render a program inoperable in addition to faulty logic in planning the program until the programmer corrects the mistake. Finding where these errors occur at and correcting them can be quite time consuming. At least the program is not lost in these cases. With punch-cards and paper-tape the programmer would have to start the programming sequence over from the beginning every time a mistake was made.

In addition to being labor intensive to input and "debug," text-based programs are cryptic in appearance and unintuitive to the untrained eye (and often times to the trained eye as well). It can take hours to determine what a program does and how it works by examining the source code for it. Needless to say, this is unduly time intensive when it comes to fixing someone else's mistakes, which happens all the time in today's computer world.

A more desirable programming paradigm may not be too far off into the future however. Software engineering in a 3-D virtual environment may prove to solve many of

the problems with current programming methods. By viewing the program as *virtual hardware* the programmer can build a program much like how a carpenter can build a desk or chair. This form of programming would be much more intuitive than text-based programming because the user can "see" the parts and relate how they work together (much how a layperson can explain some of the workings of a car engine when using an actual engine as reference, but the same person can not verbally describe how the engine works with no visual reference). Much like a child assembling a house or building out of LEGOs, a programmer can build a functional program piece by piece. Syntax errors are all but eliminated simply because if something will not work that way it will not "fit" to the attaching piece.

Furthermore, debugging a virtually designed program is much less complicated than with text-based code. Instead of finishing the program and trying to run it, then trying to figure out why the program crashed, a programmer can actually "see" his or her program run in real time and see for him or herself where the problem is and correct it right then and there. This way is clearly more time (and cost) effective than trying to sort through thousands of line of code and find the culprit.

Given the rate at which the computer industry, it is just a matter of time until virtual programming becomes a non-virtual reality. The advantages provided by programming in a virtual environment are by far superior to any other method we have today. Once this becomes a reality programming will then turn from an art form into a science - a field of engineering into which other engineering paradigms can be applied and help produce complex yet quality software for tomorrow's world.

Deposition and Deformation of an outcrop of the Upper Mississippian Princeton Formation, Mercer County, West Virginia

By
Nancy J.B. Sloan
Undergraduate Geology Research
For
McNair Scholars Program
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Mentor:
Dr. Joe Allen

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Abstract

This study focuses on the descriptive sedimentology of a newly exposed outcrop of the Upper Mississippian Princeton Formation and the upper Hinton Formation in Mercer County, West Virginia (Fig. 1), which has been exposed through ongoing construction. The contact between conglomeratic sandstones of the Princeton Formation and mudstones of the underlying upper Hinton Formation is fully exposed in this outcrop along with some deformation of the bedding in upper Hinton Formation. This research focuses on determining the depositional model that best explains the sedimentary characteristics of the Princeton Formation. The research will also interpret the cause of deformation contained within the upper Hinton Formation. Methods include field description of lithology and sedimentary structures, outcrop mapping on a photomosaic, and determination of the local depositional rate. I found that a low sinuous river deposited the Princeton Formation in this location and the deformation is due to reverse gradient loading.

Deposition and Deformation of an outcrop of the Upper Mississippian Princeton Formation, Mercer County, West Virginia

By NJB Sloan

Introduction

This study focuses on the descriptive sedimentology of a newly exposed outcrop of the Princeton Formation and the upper Hinton Formation in Mercer County, West Virginia (Fig. 1), which has been exposed through ongoing construction. Figure 2 is a sketch map of the study area. The outcrop face generally strikes east-west and measures 360 meters in length. This outcrop contains a thick exposure of siltstones and mudstones of the upper Hinton Formation below conglomeratic sandstones of the Princeton Formation (Fig. 3a &3b); deformation is contained within bedding below the Princeton Formation (Fig.4). Although there have been studies of the Mississippian Chester (Mauch Chunk) Series in southern West Virginia, these studies disagree on depositional environment and most interpretations are generalized across a large area. The objectives of this study of the Princeton Formation are to: 1) describe the sedimentary features and lithology contained within this exposure of the formation, 2) determine the depositional environment of this outcrop and suggest which previously published depositional model best explains it, and 3) determine the nature of deformation contained within this new exposure.

Previous Work –A Brief History of Stratigraphic Nomenclature

Campbell and Mendenhall (1896) first described strata now called the Princeton Formation along the New River. They named the strata " Princeton Conglomerate", and

stated that the rocks were the basal formation of strata termed the "Conglomerate Series" By William B. Rogers. This terminology was subsequently used by William M. Fontaine in his paper, "The Conglomerate Series of West Virginia". Reger (1926) redefined the Princeton Conglomerate as a single member of a much thicker interval termed the Princeton Group. According to Dyar (1957), the West Virginia State Geologist accepted group rankings for the Bluestone, Princeton, Hinton, and Bluefield groups but didn't use the formational breakdown for the Princeton Group due to the detailed work it would take for correlation. Wilpolt and Marden (1959) subsequently mapped stratigraphic cross sections of the Princeton from field work and drill data, and Russ (1969) mapped the geographic distribution of the Princeton in southeastern West Virginia. The present accepted stratigraphic nomenclature refers to the Mauch Chunk Group consisting of the Bluefield Formation, Hinton Formation, Princeton Formation, and Bluestone Formation, in ascending stratigraphic order (Stewart et al., 2002) (Fig. 5).

Stratigraphic and Geographic Distribution

The Princeton Formation is stratigraphically located in the Upper Mississippian interval of the Mauch Chunk Group (Fig. 5). The Mauch Chunk Group is interpreted as a set of clastic wedges that prograded south-southwest across a shallow-marine carbonate shelf represented by the Greenbrier Limestone (Thomas, 1989). These clastic wedges is interpreted to have occurred in response to the subsidence in the Appalachian foreland basin due to tectonic convergence and massive thrust-sheet emplacement along the Appalachian orogenic front (Miall, 1981; Thomas, 1989).

The Princeton Formation is of variable thickness and locally is as much as 30 meters thick (Reger, 1926; Dyar, 1957; Pinnix, 1993). The lithology of the Princeton Formation is generally described as a polymictic conglomerate (Reger, 1926; Pinnix, 1993; Miller and Eriksson, 2000) exhibiting a fining-upward sequence. The conglomeratic pebbles range from limestone breccia (Reger, 1926) to mudstone, shale, quartz, chert, ironstone and limestone (Englund and Thomas, 1985; Englund and others, 1986; Pinnix, 1993). The Princeton Formation contains three basal intervals of conglomerate approximately 1.3 meters thick, which contain flat pebbles of dark-gray limestone and gray and maroon mudstone which are commonly as large as 5 cm, and one bed of conglomerate that is 3.3 meters thick and contains mostly angular pieces of fine-grained limestone. The source of the angular mudstones and limestones is believed to be near depositional sites (Thomas, 1966). Cooper (1961) identified pebbles that ranged in age from Silurian to Mississippian and stated, "fragments of the Tuscarora, Clinton, Keefer, Huntersville, Devonian shales, Devonian-Mississippian sandstones and siltstones, and Mississippian limestones can be identified with some certainty." The sandstone contained within the Princeton Formation is described as gray to yellow, sub-angular to sub-rounded, moderately well-sorted, and containing trough crossbeds (Pinnix, 1993). Englund and Randall (1981) state that the Princeton Formation "becomes less conglomeratic, thinner, and eventually grades to a ripple-bedded, very fine-grained sandstone before wedging out" southwestward in Virginia and westward in West Virginia. Dyar (1957) described the Princeton Formation as consisting of several beds of shale ranging from blue-gray to green- gray containing coaly streaks and a soft coal with an underlying clay beneath a conglomerate sandstone. Miller and Eriksson (2000)

describe the upper Princeton Formation as "dominated by dark mudstone that contains plant fossils and siderite nodules."

Locally, the basal contact of the Princeton Formation is the "Upper Red" shale (Dyar, 1957) located in the upper portion of the Hinton Formation. According to Miller and Eriksson (1999) the contact between the Princeton Formation and the Hinton Formation is an unconformity. This unconformity has been confirmed by Englund and Thomas (1985; 1990) and by Pinnix (1993); however, Thomas (1959) (Englund, 1979a; Englund, 1979b; Arkle and others, 1979) interpreted the contact to be conformable. Pinnix (1993) interpreted the Princeton Formation to be an incised valley fill and Miller and Eriksson (2000) describe the Princeton Formation as clastic wedge filling an incised valley citing the fact that it is absent in the northern outcrop belt where the Bluestone Formation directly overlies the red beds of the Hinton Formation.

The upper contact of the Princeton Formation with the base of Pride Shale Member of the Bluestone Formation was previously considered conformable by some workers (Thomas, 1959; Englund, 1979a; Englund 1979b; Arkle and others, 1979). According to Miller and Eriksson (2000) however, there is an erosional surface that separates the valley-fill deposits of the Princeton Formation and the overlying marine shale of the Pride Shale.

Tectonic and Paleoenvironment Setting

The Upper Mississippian tectonic setting reflects a time of change for the Appalachian Valley and Ridge and Appalachian Plateau region. During the Late Devonian and Early Mississippian, Gondwanaland was approaching eastern Laurentia

(Stanley, 1998). Massive thrust sheets produced the Appalachian Valley and Ridge province as the two continents collided along the Appalachian orogenic front. The uplift due to thrusting caused a crustal down warping also called a foreland basin (Miall, 1981). The foreland basin became an intercontinental sea known as the Appalachian Seaway. Erosion from the uplift provided clastic sediment fill for the basin. Sediments from the north prograded across the intercontinental sea in a south-southwest pattern (Englund and Thomas, 1990).

The climate for the Appalachian basin has been interpreted as seasonally dry with episodes of wet conditions during the Late Mississippian. (Cecil, 1990) A trough of low pressure may have been influenced by the newly uplifted mountains, which permitted the influx of moisture from the western Appalachian Seaway to the Appalachians (Crowley et al., 1996; Miller and Eriksson, 2000). Miller and Eriksson (1999) state that the local presence of leached paleosols and coaly units may reflect overall wetter conditions as monsoonal rainfall became restricted to near-equatorial latitudes. Leached paleosols are interpreted as developing under waterlogged condition and are gray-white in color. Local extent and poor development of coal suggest short-lived humid conditions (Miller and Eriksson, 1999). The Appalachian Mountains would have produced an area of intensified low pressure inhibiting monsoonal conditions and producing high rainfall in the mountains (West et al., 1997). The most deeply incised parts of the paleovalleys have the thickest succession of valley fill. The most complete record of humid conditions has been preserved in paleovalley interfluves (Miller and Eriksson, 1999).

Previous Interpretations and Models

The Princeton Formation has had four depositional interpretations. Miller and Eriksson (2000) have performed the most recent work on the Princeton Formation. Through analysis of outcrops and subsurface data, they have interpreted the Princeton Formation as an incised valley deposit within major fluvio-estuarine successions. Pinnix (1993) used outcrop data, the common characteristics of fluvial systems from Miall (1977), paleocurrent data, sedimentary structures, and petrographic analysis of thin sections to determine that the Princeton Formation was a braided stream leading to a delta far to the south. Pinnix states that "Schalla (1984) and Wrightstone (1985) in their suggestion of a fluvial delta environment for deposition" were closest to what he discovered in his research, but their work was done on subsurface data that are interpreted to be the equivalent to the Princeton Formation called the Ravencliff Formation. According to Schalla, Wilpolt and Marden (1959) research on the Ravencliff Member was actually on the Princeton Formation. Schalla's research was not on the Princeton Formation but the Ravencliff Member of the Hinton Formation. This Ravencliff Member fits the description of the Princeton Formation and the Ravencliff is sometimes used as an informal driller's term for Upper Mississippian sandstones and conglomerates in southern West Virginia (Wilpolt and Marden, 1959). Another interpretation for the Princeton Formation is that it was deposited as a high-energy prograding shoreline influenced by long shore currents and tidal currents (Englund et al., 1979; Roberts, 1981)

Methods

The I-77/Mercer Springs Road outcrop is unique with respect to the extent of exposure of both the Princeton Formation and the sub-Princeton siltstones and mudstones within the upper Hinton Formation. Interpretation of depositional environment and the type of deformation contained within this outcrop could validate or disclaim previous models.

The procedures that were used for research on this outcrop are:

1) Mapping of the outcrop at a scale of 1:100 on a photomosaic base map.
2) Description of bedding and sedimentary characteristics.
3) Use of step 1 and 2 to determine depositional environment.
4) Description of structures to determine type and timing of deformation.

Outcrop Description

This exposure of the upper Hinton Formation and the Princeton Formation measures 360 meters in length and 30 meters in thickness. The outcrop faces north and runs lengthwise east to west (Fig. 2). There were no marine fossils found within the outcrop. The outcrop has been subdivided into 3 units for description and analyses, and summarized as a stratigraphic column (Fig. 6).

The lower unit, unit 1, is located in the Hinton Formation and is generally described as a Tallery-type sandstone (Sullivan, 2001). In the lower sandstone, a plant fossil of 20.5 cm in length of *Lycopsida* is displayed within the massive bedding (Fig. 7) and smaller disarticulated fragments of this genus are found elsewhere within this unit.

The middle unit, unit 2, has been broken down into 4 subunits (Fig. 6). Unit 2 is also located within the Hinton Formation. Subunit A is a blue-gray siltstone measuring 2-3 meters in thickness. Subunit B is a single organic bed of lignite measuring 10-15 cm thick on the east side of the outcrop thinning to 2.5 cm of hard sub-bituminous coal toward the west. Subunit C is a gray mudstone above the coal bed that locally contains fossils of stem nodes of *Calamites* (Fig. 8). There is also a prominent fossil of a stump (Fig. 9) above the coal seam measuring 60 cm high and 20 cm in diameter. This siltstone unit is 1-1.5 meters thick. This stump fossil can be used to estimate the sedimentation rate for this subunit. Using an estimate of decomposition for the stump at a rate of 50 years, the sediment had to have been deposited at a minimum rate of 1.2 cm per year.

Unit 3 has some plant fossils contained within the beds. The unit is hard but weathers quickly. Conglomerate clasts consist of granules to pebbles of "near source" rocks, such as limestone and mudstones, and "far source" rocks, such as quartz that is commonly sub-rounded. Unit 3 has been divided into 3 subunits. Subunit 3a is a basal polymictic conglomeratic unit. This bed is only 1-1.5 meters thick and found to be geometrically constant throughout the outcrop. Subunit 3b consists of lenticular lens of conglomerate with each len having a fining upward sequence from basal conglomerate and trough crossbeds. Unit 3c is a massive conglomeratic sandstone with a repetitive fining upward sequence contained with the bed. Lithology and thickness of all units has been described in Table 1.

Discussion and Interpretation of Deposition

I interpreted that this outcrop area was deposited as part of a fluvial system, by examination of depositional models and other key factors, such as geometry and fossils, This fluvial system has key indicators of a meandering stream with a change in the fluvial system occurring between units two and three. Unit 1 has lenticular lenses of fine-grained sands, which indicate crevasse splays or scour fills. Unit 2 is interpreted to show a progression of a changing environment from: (1) a back swamp deposit of fine-grained siltstone, to (2) a swamp deposit (coal) with rootlets from the plant growth on this floodplain, and finally to (3) waning flood deposits of mudstone. Figure 10 (cross-section A-A') shows abandoned channel cuts contained within unit 2 which extended down through the 2b coal layer and were later filled with 2d-overbank deposits. These channels, along with numerous scour fills (Fig.11 b-b'; Fig.12 c-c'; Fig.13 d-d') contained within the 2c-2d units, demonstrate an east-west migrational change in deposition. Unit 3 consists of three major subunits. Subunit 3a is interpreted as broad, shallow scour that is filled with a course-grained conglomeratic sandstone that is geometrically consistently throughout the outcrop. Subunit 3b has basal planar-laminated sands interpreted as a low-flow sequence. Subunit 3b consists of lenticular conglomerate lens, which has lateral and vertical accretionary surfaces across most of the outcrop, interpreted as point bar sequences. Subunit 3c is massive sandstone that has lenses of conglomerate contained within the unit. It is interpreted as channel fill on the basis of the geometry of the sand bodies. The geometry of the unit (Fig.14 e-e') gives an overall appearance of a sinuous stream having a bed load consisting of near and far source deposits. This is likely due to uplift of the nearby mountain range of the Appalachians.

This uplift could also trigger a change in the environment and amounts of rainfall, which could account for the repeatitive fining upward sequence and the sudden change in size of debris flow contained within this unit.

Discussion and Interpretation of Deformation

The deformation contained within unit 2 (Fig. 4) is part of the attraction of this outcrop. Although deformation can have many causes, the primary causes for this deformation is interpreted herein to be soft-sediment deformation due to either loading of overlying sand bodies or paleoseismites due to earthquake activity. Evidence for this interpretation follows.

According to Mills (1982), soft-sediment deformation can occur in response to a wide range of mechanisms. The most dominant of these are: 1) liquefaction or fluidization; 2) reverse density gradation; 3) slumping or slope failure; and 4) shear stress. High depositional rates, low permeability, and low shear strength of grains maximize the occurrence of deformation. "Making the distinction between contorted strata produced by soft-sediment deformation and tectonics is often difficult, but a reliable indication of soft sediment origin is the existence of underformed master bedding" (Mills, 1982). Soft-sediment deformation commonly occurs prior to compaction. For reverse-density deformation (sediment loading) to occur, the most favorable conditions are weakly compacted mud deposited under rapid depositional rates (8-100 meters per 1000 years), overlain by medium-grained or courser sands that were also deposited rapidly (Mills, 1982). Unit 2 was calculated to have an estimated

depositional rate of 1.2 cm/year, which equals 12 meters per 1000 years. This estimate is consistent with load-induced, soft-sediment deformation described by Mills (1982). Furthermore, the conglomerate is generally thicker above the deformation area, which could have adding to the bed load of the overlying sands.

According to Stewart et al. (2002), there are paleoseismites contained within the upper Hinton Formation stratigraphically in the same interval only a few kilometers south of this outcrop. None of the common criteria for paleoseismites established by Stewart et al. (2002) could be identified at this outcrop. Although subunits 2b and 2c appear to have been injected upward and Subunit 2d is displaced downward past Subunits 2c and 2b, there are no tabular conduits or sand- filled dikes found anywhere within the site (Fig. 4). Also there is no evidence of faulting or offset beds within the underlying Unit 1. This leads to the conclusion that the deformation contained within Unit 2 is due to reverse-density deformation due to sediment loading.

Conclusion

The upper Hinton Formation and the Princeton Formation at this outcrop location was deposited as part of a fluvial meandering system that had a change in bed load amounts due to tectonic and environmental changes associated with the Appalachian mountain building process. The deformation in unit 2 is interpreted as reverse density deformation, due to the rapid amounts of deposition recorded in the siltstones and mudstones of unit 2 as estimated by calculated rates of burial of a stump and the overlying loading of unit 3.

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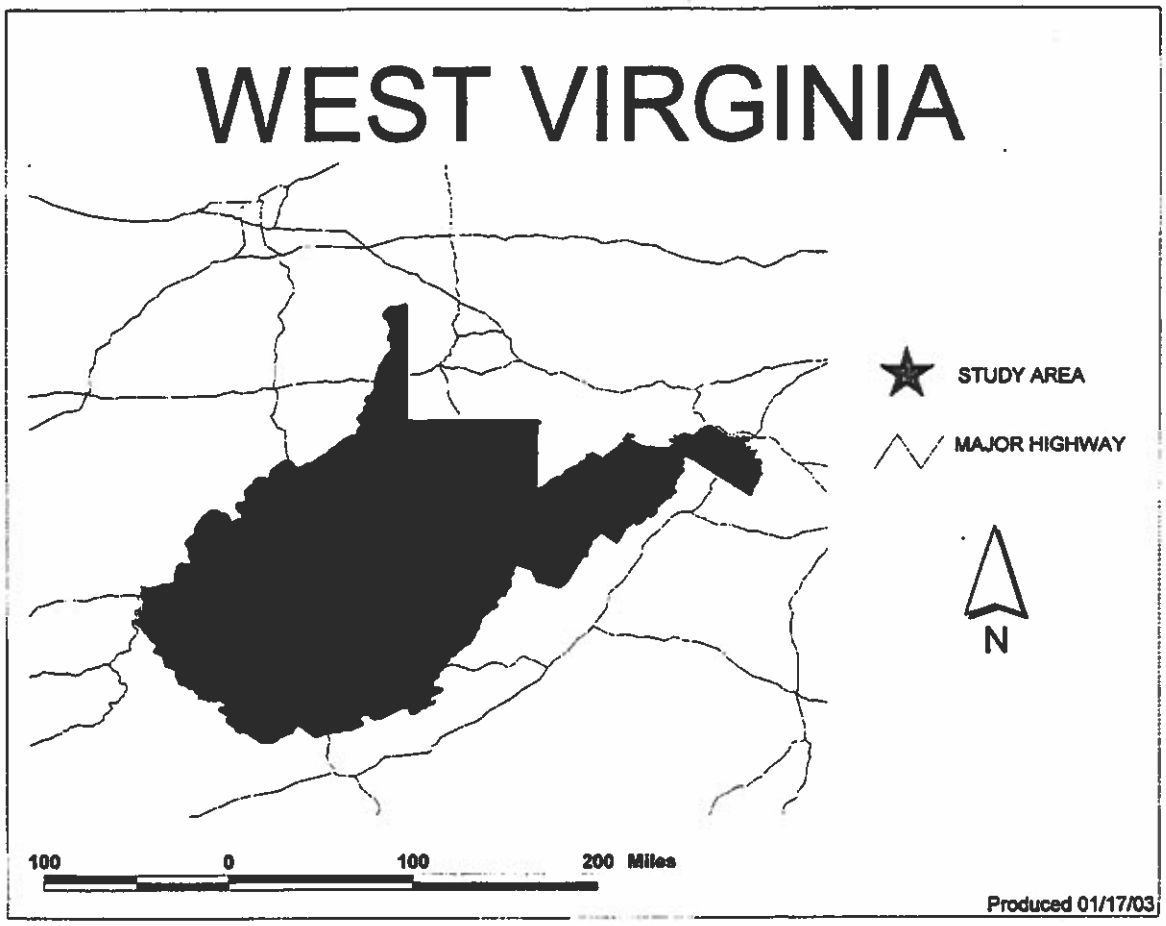

Figure 1: Map of Study Area. Produced by Aaron Hill.

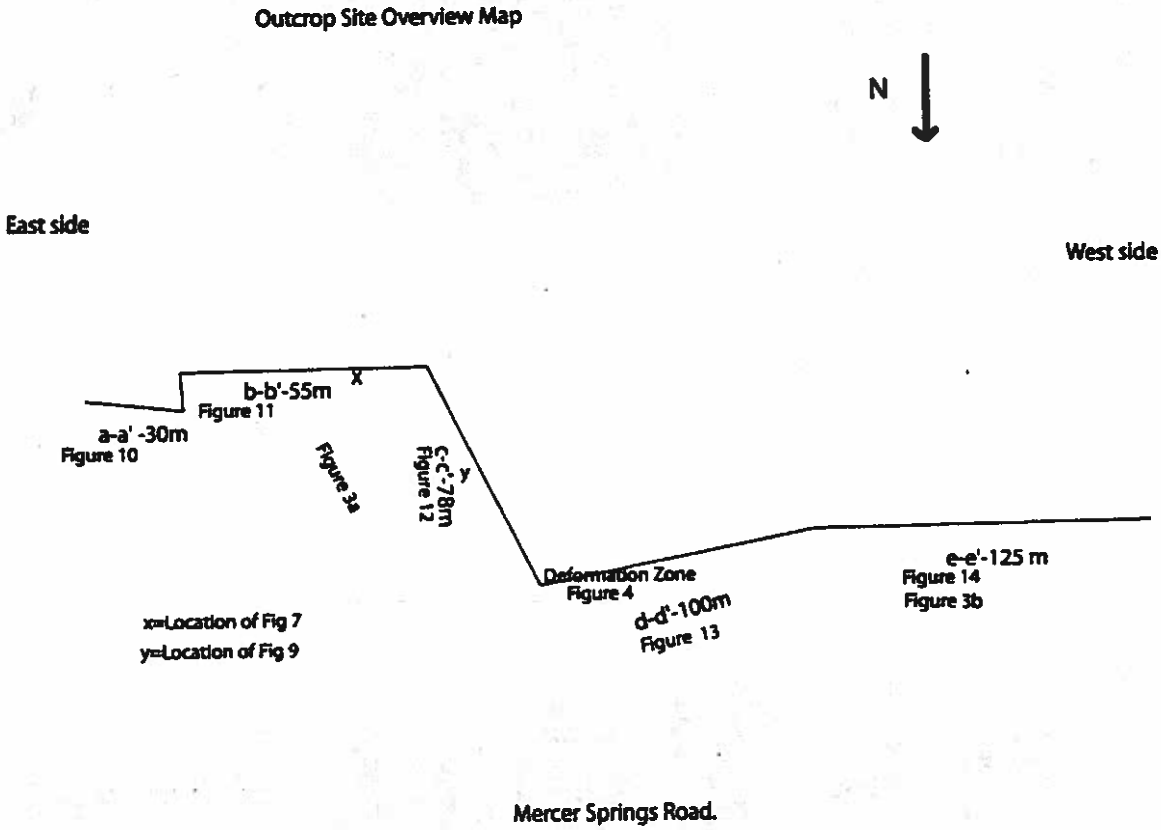

Figure 2: Base map for outcrop site. Line shows generalized trace of the north facing exposure. Location of Mercer Springs Road is approximate. Outcrop is located near the intersection of I-77 and Mercer Springs Road (Exit 14). Outcrop faces include horizontal length of exposure of 360 m. GRS coordinates of outcrop N37° 25.497' and W081° 03.745'.

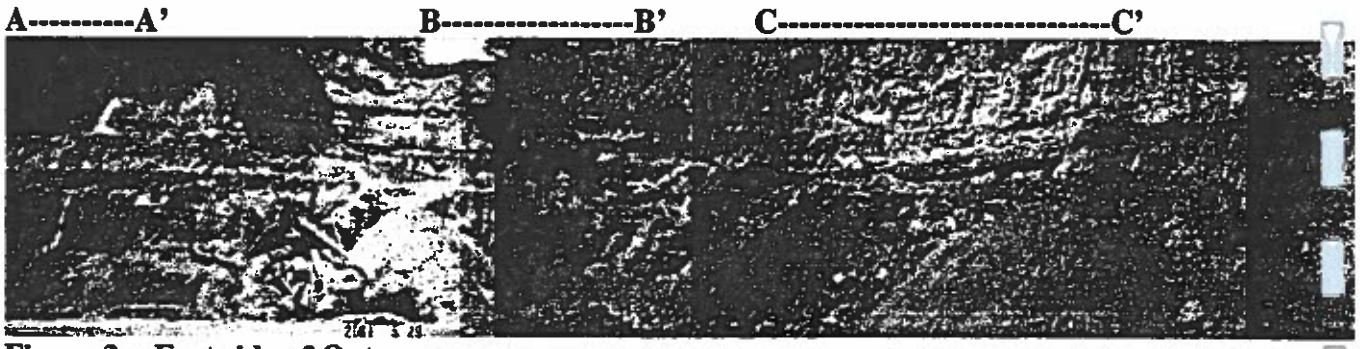

Figure 3a: East side of Outcrop

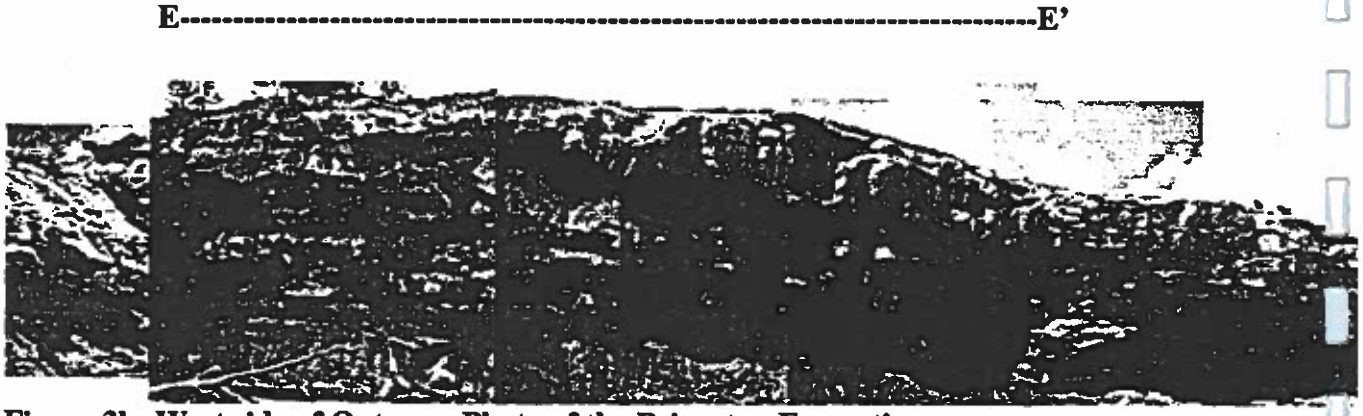

Figure 3b: West side of Outcrop. Photo of the Princeton Formation.

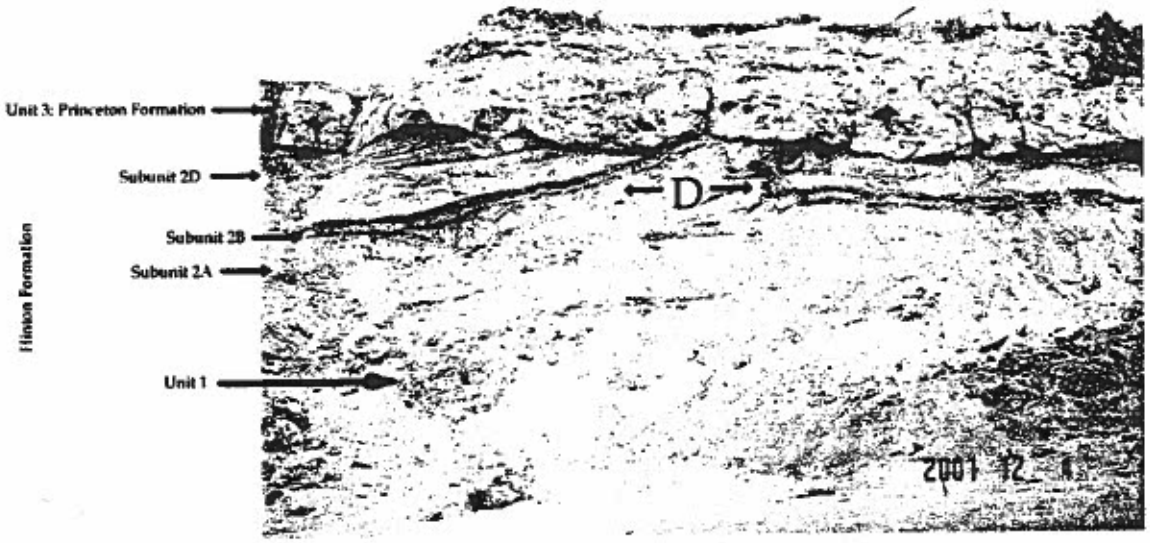

Figure 4: Deformation in Unit 2. Deformation zone located with letter D. Note that subunit 2D dips to the east (left side of photo) on the eastern flank of the deformation zone.

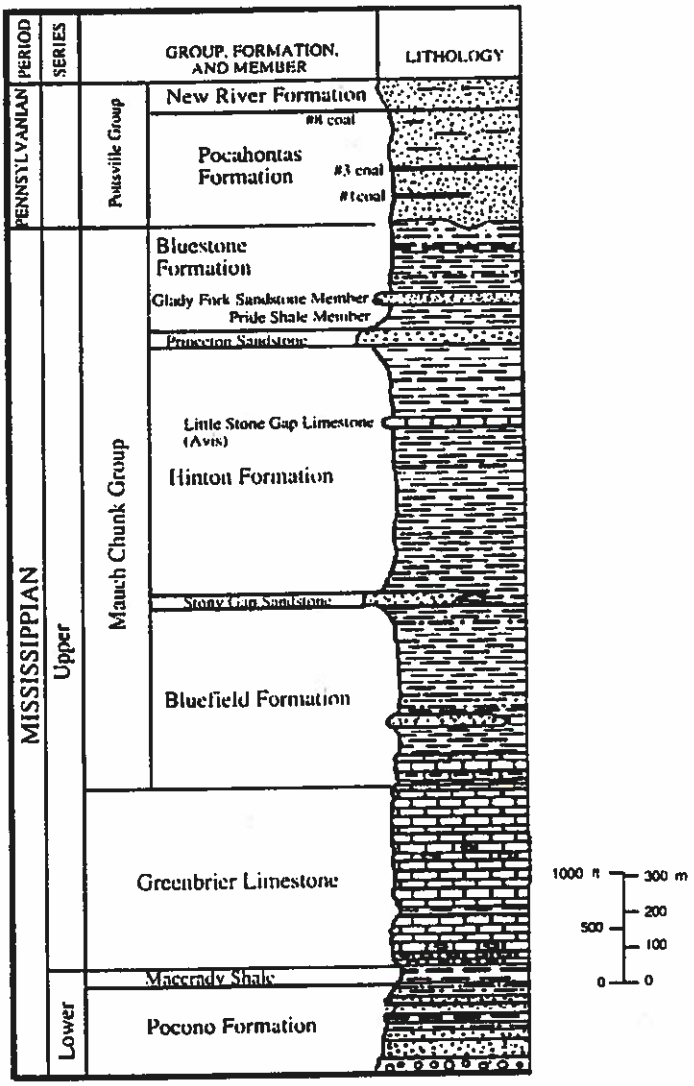

Figure 5: Regional Stratigraphic Column. Modified from Stewart et al., 2002.

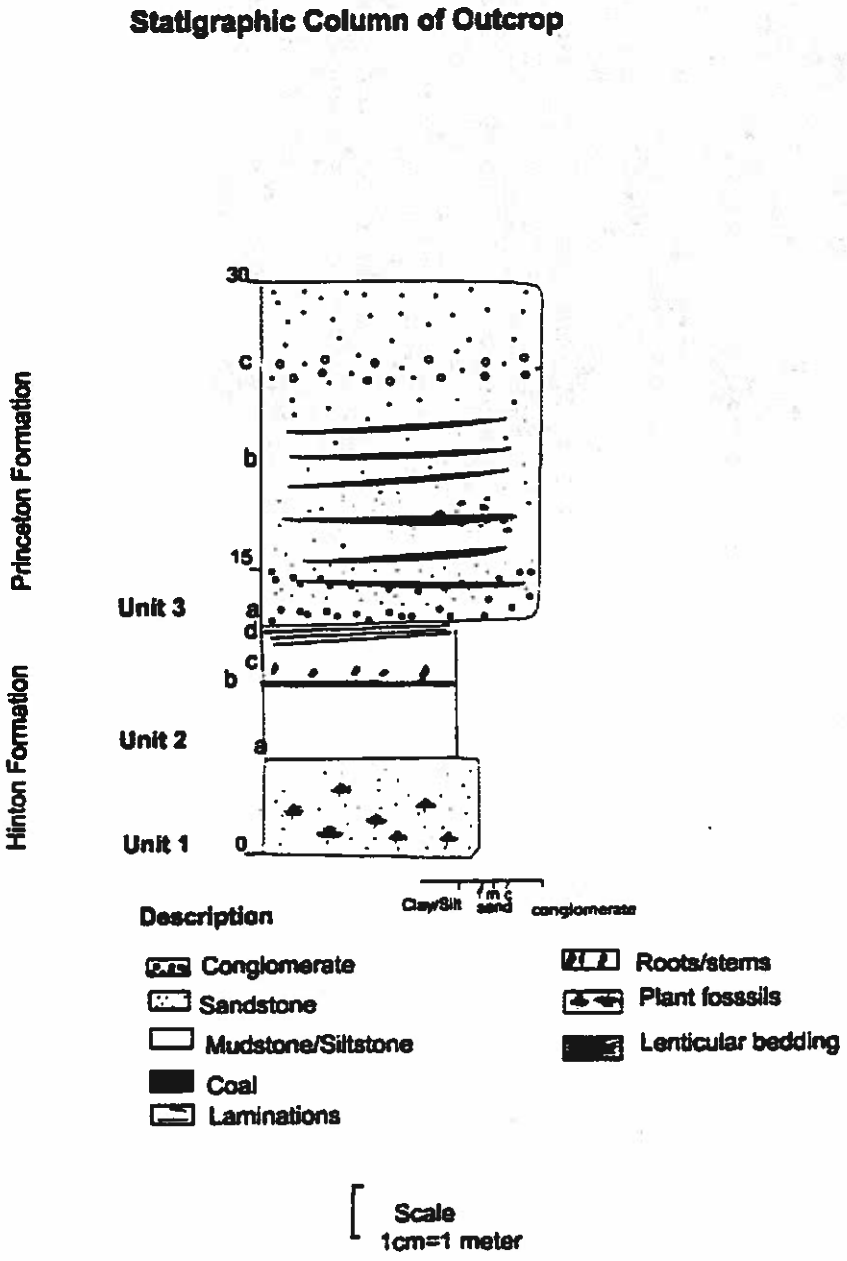

Figure 6: Stratigraphic column of research outcrop with major units and subunits.

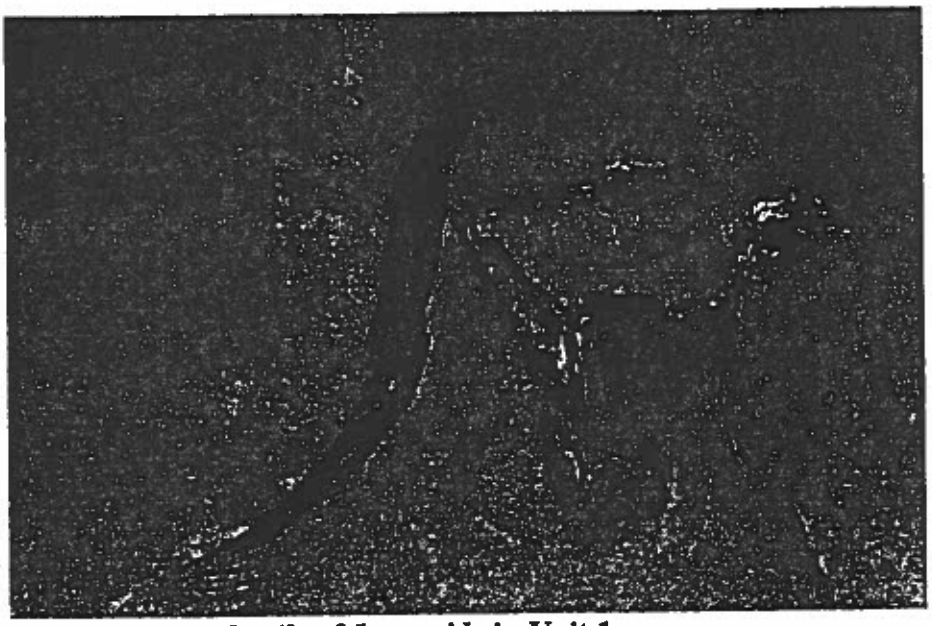

Figure 7: Plant fossils of *Lycopsida* in Unit 1

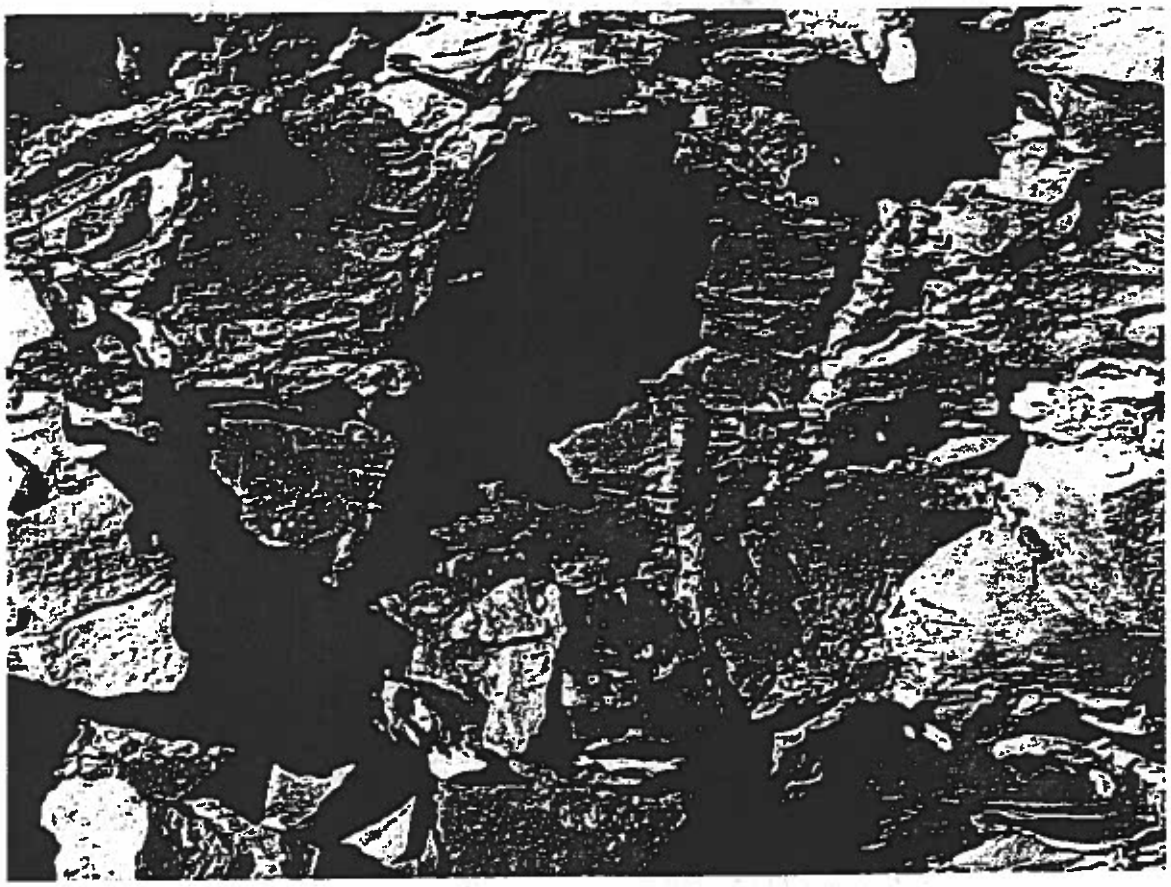

Figure 8: Fossils of *Calamites* stem nodes located in Unit 2, subunit C.

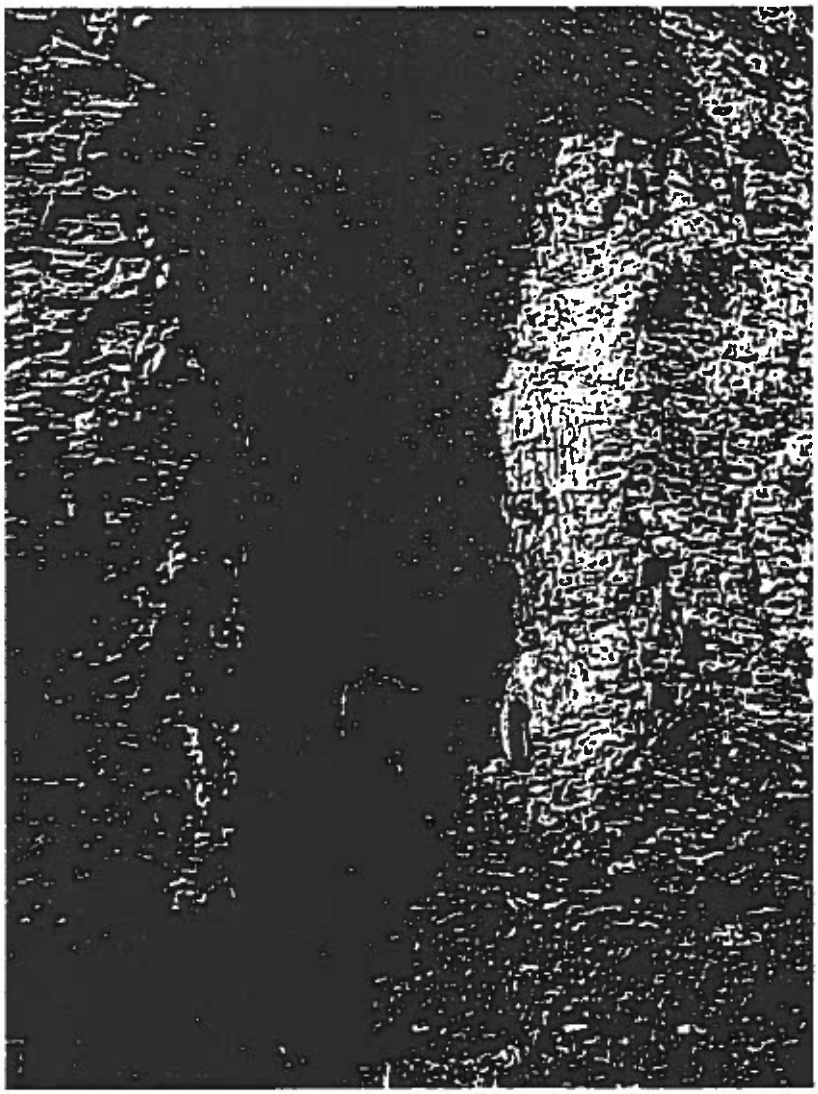

Figure 9: Stump fossil- 20 cm diameter x 60 cm height-is located in Unit 2, subunit C was used for deformation rate.

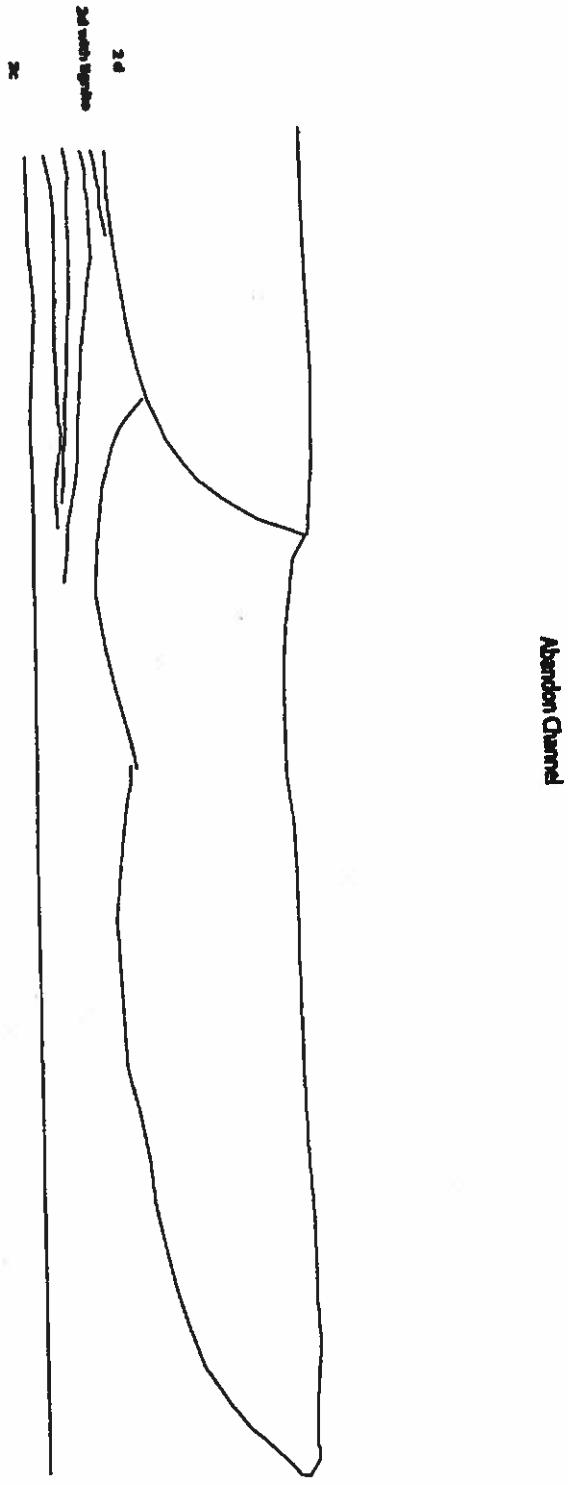

Figure 10: Located at A-A' on Base Map. Outcrop map of an interpreted abandon channel. Mapped on a photomosaic base map (Fig. 2). Channels are 30 m horizontal exposure.

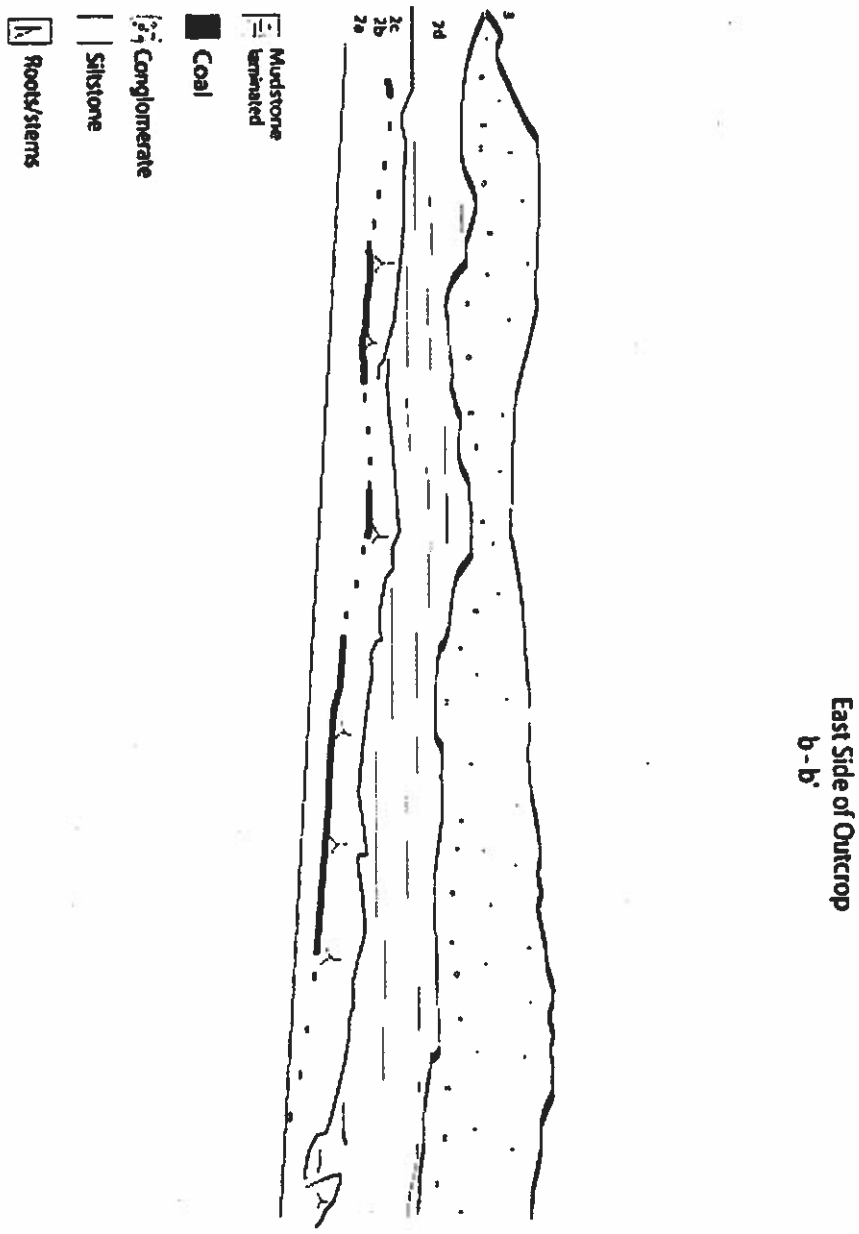

Figure 11: Located at B-B' on outcrop base map (Fig 2). Mapped from photomosaic. Photo picture of area is Fig 3a. Area is 55 m of horizontal exposure.

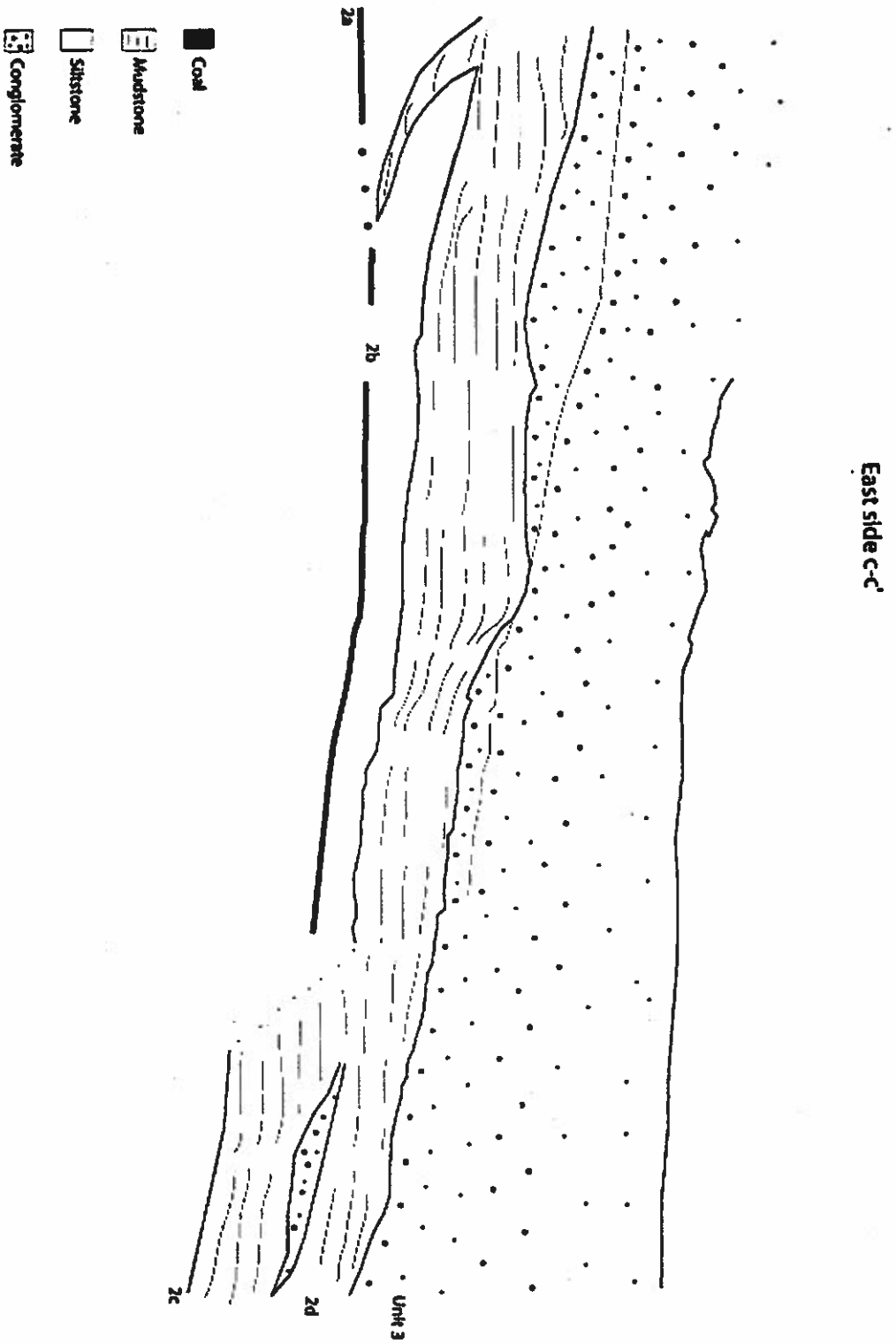

Figure 12: Located at C-C' on Outcrop base (Fig. 2). Stump fossil located in this area of outcrop. Photo of area is Fig. 3a. Figure shows 78m of horizontal exposure.

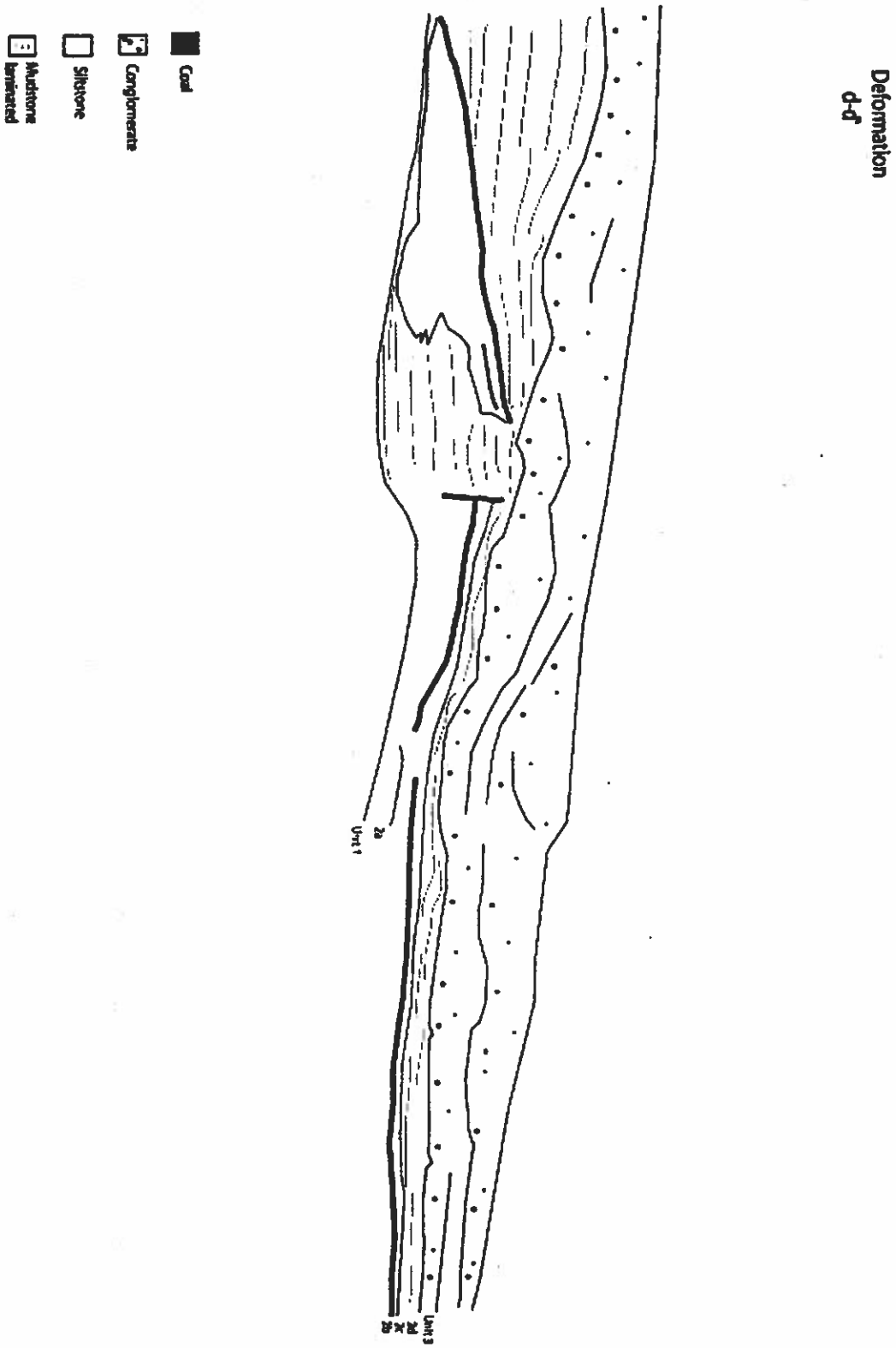

Figure 13: Located at D-D' on outcrop base map (Fig. 2). Mapped from a photomosaic of the deformation zone. Photo of deformation zone is Fig. 4. Area is 100 m of horizontal exposure.

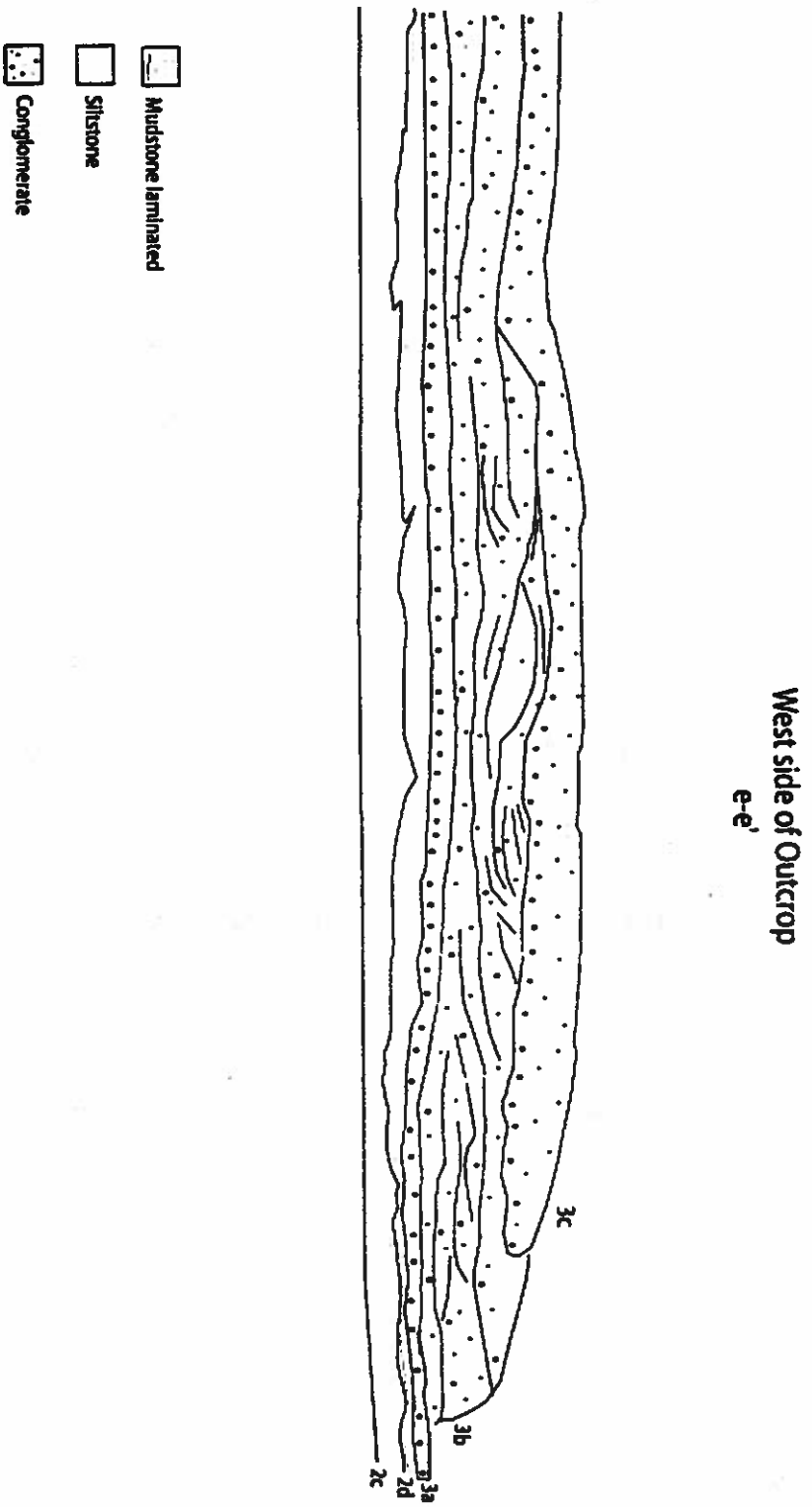

Figure 14: Located at E-E' on outcrop base map (Fig. 2). Mapped from photomosaic- best view of the Princeton Formation and the accretionary beds in Subunit 3B. Photo of Outcrop is Fig. 3b. Area is 125 m of horizontal exposure.

Maternal and Child Health in Mozambique: A Qualitative Assessment of the The Impact of Worker Training

May, 2002

By
Ruschelle Smiroldo

Report Outline

I. Review of the Literature

II. Research Design

III. Data Analysis

IV. Results and Conclusions

Outline

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II. Body

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   - International Assistance
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b. Health Concerns in Mozambique
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   - HIV
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Introduction

Mozambique is located in southeastern Africa, bordering the Mozambique Channel between South Africa and Tanzania. Slightly less than twice the size of California, Mozambique shares a border with six other African nations: Tanzania to the north, Malawi and Zambia to the northwest, Zimbabwe to the west, South Africa to the south, and Swaziland to the southwest. Population estimates range from 16,100,000 to just under 20,000,000, with an average life expectancy of 36.45 years (CIA, 2001), with males outliving females by a couple of years. The adult literacy rate is 42.3 percent, with only 27 percent of women possessing reading skills, compared to 58.4 percent of men (CIA, 2001). Throughout this impoverished country, the healthcare sector is one of the many systems that lacks organization, adequate workers, and much needed material resources. This review focuses on worker training in the healthcare sector of Mozambique by providing an historical perspective of governmental stability as well as international relief systems in the country. The review also discusses specific health concerns found across the country along with challenges faced by rural healthcare workers.

War, Peace and International Aid in Mozambique—A Historical Perspective

This section discusses the political struggles faced by Mozambique over the past one hundred years. The overview also includes information regarding the impact of international relief since Mozambique's independence including challenges and achievements. This information is the foundation for understanding the challenges of Mozambique's current rural healthcare system.

Political Struggles

In the 1890's, the Portuguese established rule in Mozambique using military force, and in 1910 Mozambique officially became a Portuguese colony. In 1926, the Portuguese took a great interest in Mozambique and built railroads throughout the region. Africans performed this hard labor for minimal pay. The Portuguese denied educational opportunities to Africans and prevented them from gaining voting privileges in their own country. In 1951, Mozambique was declared an "overseas province" and later in 1971 was declared a "self governing state." These title changes were largely due to international pressure to help improve living conditions for the African population (Accord, 1997).

While independence was being gained in neighboring African nations during the 1960's and early 1970's, Mozambique remained under Portuguese control until 1975. The fight for independence was a struggle that began 14 years earlier with the founding of The Mozambican Liberation Front (Frelimo) by Dr. Eduardo Mondlane. By 1964, Frelimo had launched an armed struggle in northern Mozambique to achieve independence from Portugal. Mondlane, Frelimo's first President, was assassinated in 1969 by Frelimo dissidents and was succeeded by Samora Michel. The struggle continued and in 1975, Samora Michel was sworn in as President of Mozambique with Joaquim Chissano as Minister of Foreign Affairs. In 1977 Mozambique declared itself a Marxist-Leninist entity and turned to the Soviet Union for assistance. That same year the Rhodesian government formed the Mozambique National Resistance (MNR, later Renamo) to overthrow Frelimo (Accord, 1997). However, in 1979, government soldiers assassinated Renamo's first leader Andre Matsangaissa. Following a long struggle,

Afonso Dhlakama becomes the new Renamo Leader. In 1980 control of Renamo was taken over by the South African military and attacks continued on Mozambique, destroying the economic infrastructure. In 1984, the United States placed pressure on the government to begin peace negotiations with South Africa but little was resolved. The Mozambican Christian Council (CCM) established the Peace and Reconciliation Commission to aid in the peace process (Accord, 1997).

In 1989, Kenyan facilitators met with CCM and Renamo representatives. South Africa's Foreign Minister, Botha discussed peace talks involving South Africa, Mozambique, the United States and the USSR. By March the number of people in need of famine relief had risen to seven million. Renamo then announced a unilateral cease-fire to allow relief agencies to enter. The 1990's were fraught with continued fighting despite continuing peace talks initiated by CCM, Pope John Paul II, and the United Nations. A new constitution was written in 1990 and in 1991 Mozambican churchmen appealed for an immediate cease-fire. Monitored by the United Nations, the General Peace Agreement was signed. This gave Renamo the right to begin political activities (Accord, 1997). In 1993 a trust fund was set up by the UN to finance Renamo's transformation. Despite the difficult transition of fighting on both sides, a single army was formed. By 1994, 81 percent of eligible voters were registered and elections took place on October 27-29. Frelimo won and Chissano was re-elected President (Accord, 1997).

Mozambique still faces many challenges in improving governmental stability. The cooperation between the executive branch and the very powerful legislature is still fragile, as are municipal governments formed after the 1998 elections. Seventy-one

percent of the population is rural with two thirds living in poverty. Forty percent of the population lives without access to health facilities and 50 percent of children die from common treatable diseases (USAID, 2001). These statistics lead to the discussion of another important factor in Mozambique's history, international aid.

International Aid

Between 1982 and 1984 the escalation of war and famine had left tens of thousands displaced or dead. Some improvement in living conditions resulted through intervention by the United States and other international relief agencies. However, the new Mozambique ministries strictly regulated relief efforts, with administration through UN agencies and individual constituents. At that time, the new government had the resources to remain selective of foreign aid. However, when debt repayment became impossible due to famine in 1983, Mozambique had no choice but to receive aid under any conditions (Hanlon, 58). By 1987, Mozambique had earned the dubious status of the world's poorest country (WB1990: table 1, 20,23, 28). The United Nations raised $330 million U.S. dollars in emergency assistance for Mozambique. Under the International Monetary Fund (IMF), Mozambique launched a "structural adjustment " program to begin rebuilding the country's economy (Accord, 1997).

By then the majority of Mozambicans suffered from chronic malnutrition, despite international assistance aimed at eradicating hunger. The citizens were not receiving enough of the valuable nutrients needed to maintain proper health, a problem that would endure even after the floods and famine ended. Aid agencies could not simply leave when the natural disasters ended. The issues of displaced persons and the lack of community infrastructures called for drastic international aid policy evaluation. Like the

economic situation, agencies needed to address the issue as a "structural problem" that required immediate action (Hanlon, 77).

In 1999 the United States allotted $60 million to the healthcare industry of Mozambique, specifically to improve management in the area of maternal and child health. That same year $64 million dollars was also allotted to rural revitalization programs, which included necessities such as improved roads increased sustainable agriculture, and financial services for small businesses (Mozambique News Agency, 1998).

Today, foreign aid makes up about 60 percent of the Mozambican national budget. The United States remains a large contributor to the Mozambican government in all aspects of development. The United States Agency for International Development (USAID) is the agency under which many international relief organizations are funded to Mozambique. In the past ten years, new community-based initiatives have been put into place to shift aid from emergency relief to sustainable development programs.[1] Examples of these programs are discussed below.

USAID's family planning and health program consists of three major program areas, one being *Improved Delivery of Essential Maternal and Child Health (MCH).* This program assists *The Ministry of Health (MOH)* and provincial health directorates in treating maternal and child illnesses. This initiative provides support to private voluntary organizations (PVO's) and nongovernmental organizations (NGO's). MCH provides strategies for organization of community health workers. MOH designs specific programs for malaria treatment, management of childhood illnesses, prenatal care, and

micronutrients. The results of this program include: First-time MCH/MOH visits in six provinces increased from 344,000 in 1994 to 432,000 in 1996; nearly 6,000 community health workers were trained through USAID programs between 1995-97 (Bureau for Africa, 1998). One major advance in planning and development is the first national census and health survey since Mozambique's independence. This was also initiated through USAID support. Currently, USAID is planning new programs in prenatal care and micronutrients mainly due to the data in the health survey (Bureau for Africa, 1998). Until the national census in 1997, little research had been found on the effectiveness of malnutrition programs in Mozambique. Data was too inconsistent and difficult to collect in some rural regions (Selvaggio, 1986).

Despite continuing political struggles, Mozambique's independence from Portugal marked the turning point for overall well being of the people of Mozambique. Under Frelimo, drastic improvements have been made in social conditions. In less than ten years of independence, the number of rural health posts had doubled; vaccination campaigns reached 95% of the population; and 81% of rural children were reported to having been seen at least once by a physician (Hanlon, 10). With the help of international relief agencies, the Mozambican government is working to improve the infrastructure of the healthcare system to provide a sustainable environment in which malnutrition is no longer a concern. This also includes providing quality skilled workers to rural areas.

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[1] Emergency relief refers to agencies such as American Red Cross that assist in temporary disaster relief situations. Sustainable development refers to ongoing programs, capacity building and development of healthcare infrastructure.

Health Concerns in Mozambique

Infectious diseases such as HIV, TB and malaria are leading causes of death in developing countries and Mozambique is no exception. These diseases, as well as cholera, diarrhea and complications related to malnutrition are all common problems facing the poor population. Mozambique is one of many developing countries that struggle with these issues. Severe droughts coupled with flooding, governmental instability and lack of resources cause ongoing challenges for international relief agencies. The following section will discuss some of the major problems faced by the healthcare sector of international relief agencies.

Infectious diseases

As stated, infectious diseases are the leading cause of death in developing countries, especially for children and young adults. The three major infectious diseases in developing countries are malaria, TB and HIV. These three cause 300 million illnesses and 5 million deaths each year.

Malaria is a tropical disease transmitted by the Anopheline mosquito. Four single-celled parasites cause malaria: *Plasmodium falciparum, P. vivax, P. ovale* and *P. malariae.* Symptoms include fever, shivering, pain in joints, headache, vomiting, convulsions and coma. According to a WHO fact sheet, internationally, malaria kills one child every 30 seconds and kills 3000 children under five every day. This toll far exceeds that of the mortality rate of the AIDS virus. Of those children that do survive, malaria drains vital nutrients from growing children impairing their physical and mental conditions during development. Malaria is also extremely dangerous during pregnancy.

It causes anaemia, often resulting in maternal deaths in Africa (World Health Organization, 1998).

Prevention and treatment of malaria are top priorities for relief organizations. Safeguards include protective clothing, repellents and bed nets. In addition to these individual actions, community-wide control efforts include the use of insecticides and environmental management to control transmission. Disease management of those already infected is also vital. Early treatment is encouraged, especially for children and pregnant women.

In an article by the *Associated Press* more Mozambicans are falling ill to malaria than in past years. Three million cases of malaria were reported in 2000, an increase of one million from the previous year. The World Health Organization (WHO) estimates that this disease infects 300 million people per year and kills one million (Associated Press, 2001). According to the Mozambican WHO representative Carlos Tiny, cholera and malaria are the biggest threats to health. Health workers have also noticed a rise in acute diarrhea. This problem is rooted in the ongoing struggle to provide sanitary living conditions resulting from flooding. The *World Health Organization* (WHO) and UNICEF are the main organizations dealing with these issues although *The World Bank,* UNDP, national governments and nongovernmental organizations are also involved (World Health Organization, 2000).

Human Immunodeficiency Virus (HIV) is another infectious disease that takes its toll on communities in developing countries. Ultimately fatal to all but a few, HIV is a sexually transmitted disease that impairs the immune system. Intravenous drug users can also contract HIV through contact with the blood of infected individuals. Most people

infected with HIV do not develop immediate symptoms although some suffer a flu-like illness within a month or two of exposure. They may also have fever, headache, and enlarged lymph nodes. More severe symptoms do not usually surface until years later; however during this "silent" period the virus is spreading and killing the immune system. Additional symptoms include weight loss, lack of energy and frequent fevers. The most advanced stage of HIV is AIDS. Common illnesses such as colds and infections have severe, life-threatening consequences for someone with AIDS, unlike the effects for an otherwise healthy individual (World Health Organization, 1998).

No vaccine is available for HIV; therefore the only prevention is to avoid behaviors or situations that may lead to infection. Sexual abstinence and avoiding the use of dirty needles are the two best ways to avoid contracting the HIV virus. Also, the risk of a pregnant woman transmitting the disease to her fetus is significantly reduced when the drug zidovudine (AZT) is administered. The Food and Drug Administration has approved many drugs for the treatment of HIV. One group of drugs known as nucleosides are used to interrupt early stages of viral replication. AZT is one of these. While these treatments do not prevent the transmission of HIV, they do slow down the spread of HIV in the body. One other class of treatments is protease inhibitors. These interrupt viral replication at a later stage. Unfortunately, HIV can become resistant to theses drugs; therefore it is necessary to use each one at different developmental stages (U.S. Department of Health and Human Resources, 1999).

In the latest statistics provided by the United Nations, 16 percent of adults in Mozambique are infected with the HIV virus, with 700 new infections occurring daily. The first AIDS statistics in Mozambique were reported in 1985, but have proven to be

very inaccurate and underestimated the damage caused by this disease. In May 2000 the National AIDS Council was instituted to combat the disease (ReliefWeb, 2001). In a report issued by the *Integrated Regional Information Network* in June 2000, the spread of AIDS is growing rapidly, especially in the central and northern provinces of Manica, Sofala, Tete and Zamezia. One million children are expected to be orphaned because of this disease. UNICEF has spent $3 million dollars in Mozambique to combat HIV/AIDS (Integrated Regional Information Network, 2000).

Malnutrition

According to the *Africa Bureau Results Package of 1998,* malnutrition is the underlying cause of almost two million child deaths each year in Africa. It is also the causative factor in three out of five cases of maternal death in Africa. Malnutrition exacerbates complications from other infectious diseases commonly found in Africa such as measles, malaria, diarrhea, and pneumonia (Africa Bureau, 1998). One report issued by the *World Health Organization* states that children suffering from malnutrition are much more likely to die from diarrhea, acute respiratory infection and diarrhea. Malnutrition increases the frequency of illnesses, which increases the need for medical attention. While childhood malnutrition has decreased worldwide over the past twenty years, African countries have either remained the same or increased. It is predicted that by the year 2010, every third person in Africa is likely to be malnourished (Africa Bureau, 1998).

Malnutrition is defined as "a condition caused by inadequate intake or inadequate digestion of nutrients." According to *The American Journal of Diseases of Children,* most estimates of malnutrition are based on estimates of poor linear growth (low length

for age L/A) and thinness (low weight for height) (Gayle, Dibley, Marks, and Trowbridge, 1987). Other common measures of malnutrition are body mass index (BMI), dietary intake, physical findings, and plasma levels of nutrient dependent substances, such as hemoglobin, thyroid hormones, transferring, and albumin (Merck, 2001). Malnutrition may result from eating an unbalanced diet, digestive problems or absorption problems (Medical Encyclopedia, 1996).

Dehydration is a major problem closely linked with malnutrition. Defined as the loss of water and salts, dehydration in children is usually caused by diarrhea. One of the most effective ways to restore liquid and nutrients quickly is through the use of oral rehydration therapy (ORT). ORT is an inexpensive, simple way to treat diarrhea (Rehydration Project, 2001). A glucose and electrolyte solution promoted by the World Health Organization, ORT has reduced the number of deaths from dehydration due to diarrhea by about one million per year (Canadian Journal of Pediatrics, 2000).

While ORT has been promoted by relief agencies in Mozambique since 1977, success has hinged upon geographic location. There is been a significant difference between the recovery rates from dehydration in the capital city of Maputo, for instance, when compared to other regions. In Maputo, 93 percent of homes had the proper bottles, salt, and sugar to give ORT; however in other areas the in-home availability of necessary bottles ranged from 7 to 47 percent, and salt and sugar availability ranged from 0 to 60 percent (World Health, 1997).

Lack of a healthy diet and nutrients leads to stunted physical and mental growth, anemia, pregnancy complications and blindness. In most developing countries, hunger disproportionately affects females. Because of this, women have more nutrient

deficiencies, which makes pregnancies and fetal health much more difficult (Gardner & Halweil, 2000). Malnutrition in children often leaves them scarred for life. These children suffer from poor immune systems, neurological damage, and they are more susceptible to infectious disease (Gardner & Halweil, 2000). These factors affect society through a dangerous cycle: Poor nutrition leads to poor performance in school, which leads to rising health care issues (Gardner & Halweil, 2000).

Maternal malnutrition is an on-going problem in Mozambique, particularly in rural areas. Closer to the capital city, only 3 percent of mothers are reportedly malnourished, with the city of Inhambane also enjoying a low level of malnutrition. The highest prevalence is found in Zambezia (18%) (USAID, 1997). A mother's nutritional status affects her ability to carry, deliver and care for the baby and is therefore of critical importance. Childhood malnutrition is also rampant in Mozambique, with 44 percent of children under five dying from malnutrition-related illnesses each year. Note that only eleven percent of these deaths are due to severe malnutrition, while the remaining thirty-three percent are due to mild to moderate malnutrition (USAID, 1997).

Several reports cited later in this report reveal the fact that rural areas are most at risk of the health issues just discussed. The following section discusses similarities and differences in rural and urban areas of the country specifically related to worker training.

Rural versus Urban

Before Mozambique's Independence in 1975, very little research or evaluation was conducted on maternal and child health. Even as late as 1986, sufficient data and statistics had yet to be collected. In the 1986 *Report On The Status Of Mozambique,* by USAID/Swaziland, the National Nutrition Status Section states that surveys only

represent fragmented information; they are taken from small sample sizes, and cannot provide information on the less severe (but equally as threatening) forms of malnutrition. Due to insufficient data collection, the damage caused by malnutrition was undoubtedly underreported. The report does, however, state that in dislocated and remote regions rural families appear to be the most vulnerable because they may lack the means for sustainable crop production (Selvaggio, 1986). Further, the report states that refugees and isolated families that are dependent upon subsistence farming are at greatest risk because they have the most difficulty recovering from droughts. This includes, but is not limited to the interior of Inhambane Province as well as Tete Province (Selvaggio, 1986).

Since 1986, much progress has been made on data collection, including a much-needed 1997 census conducted by the Mozambican government. In 1997, USAID and The Ministry of Health Mozambique also published the *Nutrition of Young Children and Their Mothers in Mozambique.* It is noteworthy that as one travels north (away from Maputo, the Capital), instances of stunting and wasting increase. In rural Cabo Delgado fifty-seven percent of children under three display signs of stunting, while only sixteen percent of children under three display signs in the semi-urban region of Maputo. The statistics are similar when discussing wasting. Wasting in Cabo Delgado and Tete stands at sixteen percent, with only two percent reported in Maputo (USAID, 1997). From a strictly urban vs. rural perspective, 39 percent of rural children are stunted compared to 27 percent of urban children under three. Interestingly, a larger proportion of children in rural areas suffer from chronic malnutrition than urban, while a larger proportion of urban children suffer from acute malnutrition than rural (USAID, 1997). A discussion of contributing factors is missing from the literature.

Another report issued by USAID states that in some rural parts of Mozambique, agencies have focused on volunteer training. The report states that nearly 6,000 community health workers were trained through USAID funded programs between 1995 and 1997. One example of the impact of this training is the case of World Vision. A community based "Care Group" initiative saw a rise in the use of oral rehydration therapy by mothers from 37 to 80 percent. Also, prenatal consultation rates in two districts increased from 30 to 83 percent. From these reports, volunteer training—or the education of skilled workers--does appear to have an impact on educating mothers. These and similar initiatives are now being used as models in other rural areas across the country (Bureau for Africa, 1998).

Impact of Training on USAID Programs

Emergency relief remains essential to Mozambique in times of flood and famine; however, program funding is beginning to focus more on sustainability, including improvements in infrastructures on national and local levels. In developing countries such as Mozambique, it is important that program efficiency be assessed for maximum benefit in both rural and urban areas. This section will examine the impact of skilled workers and continued training on the success of such programs.

In recent years, Mozambique has turned attention to rural revitalization. In an activity data sheet on *Increased Use of Essential Maternal and Child Health and Family Planning Services,* USAID states that they have a new focus on rural areas where health conditions appear to be the worst. The target problems in this report revolve around training. USAID strives to improve the skills of Ministry of Health (MOH) workers and provide technical support in decentralization services. As a result of these structural

changes planning and human resource management, budgeting and financial management improvements, and services to clients have been strengthened (USAID: Data Sheet, 2001). These are mentioned below.

Project HOPE

The People to People Health Foundation implemented Project HOPE in 1996 in collaboration with the Ministry of Health. Due to the struggle of civil war, Mozambique required massive planning and implementation to address the wide range of needs for one of the poorest and least developed countries in the world. The MOH has identified Zambezia, the most populated province, as one of the least favored in terms of international aid. With a population of over two million, the economic activity is mostly family agriculture. There are no banking facilities and social services are limited in this area (Sanabria, 2000). Project HOPE's main strategies include community education, training, supervision, and follow-up of *activistas* (community health volunteers) activities. Other plans include continuing education, as well as assistance in improving planning and information systems (Sanabria, 2000). Project HOPE focused on improving areas including immunization, diarrheal diseases, child spacing, STD's/AIDS/HIV, and possible nutrition intervention. The goal was to decrease mortality and morbidity in children under two and women of reproductive age (Sanabria, 2000).

Interventions and analyses were conducted on the quality of services for Project HOPE. Areas such as the need for qualified health staff and structured supervision were examined. Trainings then took place in stages focusing on one area at a time. All training was for MOH staff. Since the initial development phase, Project HOPE has dealt with a shortage of public health workers in rural areas. These issues were addressed in

several ways including revised work schedules of employees, greater use of community structures, empowering the community, special training, and motivation of volunteers (Sanabria, 2000). The report explains that the criteria used to choose participating localities were factors such as access to services, population base, levels of need, and community response. The methodology used for this study was a final survey that was compared to a baseline. These results provided a measurement of changes in maternal knowledge and practices that have occurred in the target communities (Sanabria, 2000). Relying on this data, USAID determined that quality services are lacking in rural areas (Sanabria, 2000).

Terre des Hommes' Child Survival Project

One other program funded by USAID is that of a Swiss Nongovernmental Organization, *The Terre des Hommes*. In 1995 funds were used to initiate the Child Survival Project. War had destroyed not only the health sector, but also the entire socioeconomic infrastructure. According to the report, there is a tremendous need for basic drugs and equipment. Revitalization begins with renewal of trained staff, implementation of health policy, and drugs and equipment supplies. A major issue that limited activities was the inability to reach individuals in rural areas. The June 1997 report stated:

> "...activities are limited to the district headquarters (Maputo) and a greater proportion of the population which actually lives in villages in distance from 30-100km away from the district headquarters do not have access to health services. Untrained personnel whose activities are usually unsupervised man the available few health posts" (Lagunju, 1997).

World Vision Relief and Development, Inc.

World Vision Relief and Development, Inc. is an organization that became increasingly aware of the desperate conditions in Mozambique. The organization initiated two programs that targeted rural health. In 1990 World Vision received a grant from USAID to implement programs in rural areas to increase immunization, train mothers with under-twos on correct weaning, show mothers to correctly administer oral rehydration therapy, and to train new health care workers. The overall program goal was to reduce child mortality and morbidity (Amayun, 1990).

In 1994, World Vision implemented a similar program. The project's report noted that the groups most vulnerable to malnutrition were children under two years, and pregnant and nursing women. Rural areas suffer most from governmental instability by lacking effective infrastructures. Nutritional problems of rural areas are exacerbated by basic resources such as clean water, adequate food and basic health knowledge (oral rehydration techniques, weaning, child spacing) (USAID: Contract Information Management System, 1994). This program helped to strengthen the infrastructure and provided quality workers. While the same problems existed in the more populated areas of Mozambique, the rural population required additional planning and implementation to catch up with their urban counterparts.

Save the Children Federation

In their 1997 annual report executive summary, Save the Children Federation (SCF) stated their main goals for improving overall quality of programs. The objectives included: (1) the training and retention of community health workers; (2) the construction and rehabilitation of health posts; (3) staff housing; and (4) strengthening the linkages between 26 rural communities and the formal health system (Save the Children

Federation, 1997). One SCF rural program entitled *Community-Based Health and Rural Development Project* had an overall goal to "improve the health of rural families in the project focus area, with particular emphasis on children 0-5 and women of reproductive age (15-49 years)." The health component of this program fell directly under USAID's Strategic Objective 3: *Increased Use of Essential, Community Based Maternal and Child Services in Focus Areas.* This program, like the several others mentioned, worked to solve the overwhelming need for services in rural areas (Save the Children Federation, 1997).

The purpose of the SCF April 1997 Final Evaluation was to report the findings of numerous evaluations conducted on the projects implemented by SCF. Generally qualitative in nature, the studies' evaluations employed methods such as interviews, surveys, discussions with SCF staff and representatives of collaborating agencies, focus groups, and community meetings and sought to determine whether or not project objectives were met. Health project components fell into three categories: (1) training of community-based promoters and traditional health workers; (2) rehabilitation/ construction (physical and functional) of health units; and (3) strengthening linkages between twenty-six communities and a formal health system (Save the Children Federation, 1997). For the purpose of this literature review, training of community workers will be the only category examined.

The first objective addressed in the training section was the improvement the skills of aid worker through refresher courses on relevant topics. The target goal for the project was to administer refresher courses to ten MCH nurses. The goal was exceeded with the

training of one additional nurse. The refresher course contributed significantly to sustainability by improving worker skills (Save the Children Federation, 1997).

The second objective addressed improved access to services through basic training in child survival and maternal care, including primary and preventative health care. The target included the training of fifty traditional birth attendants (TBA's) and 360 *activistas,* or community health promoters, trained to deliver basic health and hygiene messages as well as information on ante-natal care, infant growth, and interim measures for diarrhea management. The objectives were achieved and exceeded with the training of an additional 79 TBA's as well as an additional 16 *activistas* (Save the Children Federation, 1997).

Conclusions

Mozambique, a country torn by civil war for generations has made improvements over the past twenty years in restoring the political, economic, and healthcare infrastructures through the help of many international relief agencies. This review has discussed an overview of events that have brought Mozambique to its current condition. It also examined the impact of international relief, specifically the United States Agency for International Development (USAID) on Mozambique's development. These agencies help to ensure the needs of the most vulnerable populations are met. Children under three and women of reproductive age fall into the category of "most vulnerable." The majority of deaths in these populations result from illnesses that can be easily cured or prevented. This review also discussed several of these common illnesses and preventable diseases. Also discussed, was the challenges faced by rural communities such as poor service delivery and lack of resources. Although many improvements have been made in

Mozambique, within the current system these preventative methods are still limited in rural communities. Lastly, one of the key issues impacting service delivery is the impact that worker training has on that system. USAID has thoroughly assessed the desperate needs of those in rural areas of Mozambique. International aid agencies are left with the daunting challenge of finding effective ways to serve provincial areas.

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Research Design

Statement of the Problem:
The purpose of this study is to identify the impact of worker training on success of projects dealing with maternal and child health in Mozambique. Success is defined as meeting and/or exceeding goals set by the agency before and during interventions. The research question is stated: What is the impact of worker training on improving the success rate of USAID funded programs in rural Mozambique between 1986-2001?

Hypothesis:
The hypothesis is that in rural areas that already lack basic resources to meet the goals of USAID agencies, continued training of workers (including those in the formal and non-formal healthcare sector) will increase success rates of USAID funded programs as well as decrease worker turnover and burnout.

Delimitations:
This study will examine programs funded by USAID as well as related journal articles.

This study will only analyze programs specifically within the healthcare sector (example: excluding food aid programs).

This study will acknowledge, but not focus on issues such as transportation problems and lack of equipment.

Definitions:
USAID: United States Agency for International Development is the agency responsible for distribution of funding and implementation of relief programs abroad.
Traditional Healing: Method of healing used before conventional medicine mainly revolving around spiritual, psychological, and social healing techniques.
Formal healthcare system: refers to western-style, public and private forms of healthcare.
Nonformal healthcare system: Refers to those workers trained in traditional healing methods such as traditional birth attendants, community health workers, and traditional healers.

Importance of the study:
There are two main reasons why the study of worker training in USAID funded programs and its variables is important. One, the healthcare system in Mozambique currently fails to meet the needs of those most vulnerable i.e. women and children under five in rural areas. Methods of increasing knowledge and quality care in these areas are vital to the health of these populations. Second, as cited in the literature, the United States spends billions of dollars per year on international relief. Program effectiveness is important in policy issues that determine which areas receive funding.

Methodology

The methodology used to conduct this study is a multiple case study design as outlined in Robert Yin's *Case Study Research: Design and Methods.* Twenty-five program evaluations were gathered from the USAID main office in Washington DC. Of these 25, 11 are relevant to worker training within the healthcare sector. By using this method, the 11 program evaluations gathered are first individually reviewed to locate success and failures relating to the impact of worker training on program effectiveness. A list of program evaluations analyzed is below:

- Family Planning Service Extension and Technical Support (SEATS) Project, April 2000 Mozambique Final Country Report. Note: this report contains four studies.
- A Study of Early-Stage Contraceptive Users in Mozambique, 2001
- Appraisal of the National Integrated Programme of MCH-FP, EPI, Youth and School health Mission report, 1999.
- Terre des Hommes Child Survival Project, August 1997 Report of Preliminary KPC Survey
- Africa Bureau Results Package, October 1998
- Report on the Status of Mozambique, 1986
- Project HOPE, Improving Mother and Child Health in Ile District, Zambezia, Mozambique, July 2000
- CARE Mozambique October 1999, Third Annual Report

Individual reports are written for each. A cross-case analysis is then conducted on cases that contain similar content. For example the *1997 Sage the Children Federation Report* and the *1999 CARE Mozambique Final Report* both discuss the incorporation of nonformal healthcare workers within the formal sector.

Within the results section, various journal articles and reports from organizations such as the *United Nations Population Fund* are cited to provide explanations of specific program activities and objectives. A list of Journal articles used is below:

- Making Pregnancy Safer in Mozambique: A Human Rights-Based Approach, online 2001
- Traditional healers in other parts of the world, 1998. online
- Traditional Healers in South Africa, 1998. online
- Health Care in Africa: The current state of healthcare, 2001. online
- United Nations Population Fund, Ensuring Skilled Attendance at Birth, 2001. online
- BASICSII, About BASICS, 2001. online
- Mozambique Activity Data Sheet,

In an article written by Karen E. Winegardner, the author states that case study data collection is typically muti-method. This is the case for this research report. By reviewing historical points throughout the healthcare sector, program goals and objectives are clearer. Also, clarification goals and objectives within programs can be better examined with supplemental journal articles related to policy issues.

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Winegardner, Karen E. (2001) The Case Study Method of Scholarly Research. *The Graduate School of America.* [online] Available: http://www.tgsa.edu/online/cybrary/case1.html.

Results and Findings Outline

I. Introduction
II. Body
    a. History of Healthcare in Mozambique: 1975-1986
    b. Worker Training: Review of Program Evaluations
        1. Save the Children Federation, CARE Mozambique
        2. Training Workers to Communicate With and Educate Communities
    c. Supervision and Monitoring of Trained Staff
        1. CARE Mozambique, Project HOPE, Making Pregnancy Safer in Mozambique
    d. Capacity Building and Organizational Development
        1. Making Pregnancy Safer in Mozambique, Save the Children Federation

III. Conclusions

2001-continuing: United States Agency for International Development

Activity Data Sheet for FY 1996 through 2003

This data sheet serves as an overview of many of the programs further analyzed in this study.

Summary: Health status of Mozambicans is far below international standards. Progress is delayed due to high levels of infectious diseases, malnutrition, HIV/AIDS, and a limited number of trained health professionals. USAID seeks to improve health conditions to the rural poor (80% of population). Since 1992, the number of Mozambicans receiving health care has increased fro 30% to 60%. Principal Contractors, Grantees and Agencies include World Vision, Save the Children, Pathfinder, CARE, Health Alliance International, Medical Care Development International and Project Hope.

Key Results:
"Preliminary data from a 2000 national survey indicate significant improvement in immunization coverage, prevention and treatment of diarrhea and malaria, reproductive health services, HIV/AIDS awareness, and use of condoms. All program targets were met or exceeded in the eight province program area."

The only problem area shown in the study is the number of assisted deliveries remained unchanged. This is due to the continued lack of trained attendants.

April 2000: Mozambique Final Country Report

Summary: USAID requested the Family Planning Service Expansion and Technical Support (SEATS II) assist USAID funded PVO's to integrate family planning and reproductive health into their child survival programs. The four PVO's involved are Save the Children Federation, World Relief Corporation (Both in Gaza Province), Terre des Hommes (Sofala Province) and Health Alliance International Manica and Sofala Provinces).

SEATS Country Strategy:

- Continuous quality improvement of care
- Sustainability of programs through financial and programmatic evaluations
- Monitoring and evaluation
- Performance Result 2: designed to increase the capacity of PVO's to design, implement, monitor and evaluate quality of programs
- Women's Literacy Initiative

Accomplishments

Improved access to reproductive health services:

- Through World Relief Corporation, Save the Children Federation, and Terre des Hommes, 114 Community Based Reproductive Health agents are operational in Gaza and Sofala Provinces. All of these have been trained in the use of Information, Education and Communication (IEC) materials.
- Establishment of youth corners that operate two clinics in Beira. Twenty-two service providers have been trained as well as peer educators in seven schools.
- Development, testing, production and dissemination of IEC materials has increased access to services.
- Health Alliance International implemented a number of educational activities including theater, dance, song, individual and group discussions.

Improved quality:

- Quality training provided to staff from all Mozambique subprojects and additional MOH representatives. Following training, each subproject developed a quality action plan, which operate at the health center level in each of the subprojects. The teams meet on a regular basis to discuss progress and constraints.
- Quick Investigation of Quality (QIQ) was used in three health delivery sites, which averaged around 30 clients per site. Results reported that nurses' counseling and technical skills were not optimal. Waiting times were long and less than 60% of providers encouraged their patients to ask questions. New clients were not screened thoroughly for contraindications and infection prevention measures were not taken consistently.
- The endline QIQ showed an improvement in counseling skills, waiting times were reduced and counseling skills were improved.

Improved sustainability:

- Sustainability plans were established in each of the subgroups. Issues addressed included: creating demand for services, strengthening MOH capacity to support

community-Based Distribution (CBD), strengthening the relationship between the MOH and the community.

- Technical assistance provided by SEATS along with contraceptive logistics projects, consistent inclusion of MOH officials and representatives in project planning, implementation and monitoring, development of supervisory tools and training, and proposal preparation assistance prompted many achievements. Those include: an increase in training capacity through the training of trainers, proposals prepared and submitted to various donors, increased community participation, establishment of monitoring and supervision systems, training and meeting of community leaders.

Attention to Youth:

- Youth corner was established in Munhava Health Center.
- 22 health providers received training on adolescent reproductive health (RH). Five of the 22 began working immediately. Youth corner staff workload has decreased.
- There a re currently 23 trained peer educators and it is hoped that more will be trained to further reduce caseload and turnover rate.
- Reference manual has been put together on RH for peer educators whose role includes educating the community members about youth RH.

Recommendations

- Subprojects such as this should have longer timeframes to insure adequate implementation.
- In-country cooperation is critical and should be established in the beginning.
- Monitoring and evaluation projects should be planned at the project design phase. Evaluations implemented later did not always give an accurate measure due to lack of baseline data.
- It is best to work with groups that are already known in the community.
- Training followed by continuous supervision helps retain new knowledge and is more effective than training alone. The health workers also appreciate supervision. Supervision visits should be routine and not limited to Service Delivery Points (SDP).
- Supervision should be on a monthly rather than weekly basis. This regular supervision also improves morale of healthcare workers.
- To make supervision more effective, it should include training and guidance, troubleshooting, identifying problems, and setting goals and objectives.
- Community awareness has increase through activities targeted at the community level.
- Training has helped to increase interest in improving provision. This can be seen through Nurses using more IEC materials and flipcharts.

1986: Report on the Status of Malnutrition Mozambique

The report was prepared for one reason relevant to this research analysis, a summary of current nutritional status in Mozambique. This data could not be regarded as a comprehensive analysis due to the lack of documentation available at the time (1). Security problems made it difficult to survey the nutrition status of the country. However, Nutrition professionals made some assumptions regarding malnutrition. According to the report, these professionals believe that malnutrition is more widespread than indicated. They also stated that the most vulnerable groups are refugees and rural families (4). Although this report is not directly related to healthcare, it is impossible to discuss malnutrition and food distribution without discussing infant mortality, low birth-weight, infectious diseases and other illnesses related to malnutrition (12).

According to the report, only a small proportion of the Mozambican population has access to primary healthcare services. The report states that there are no community health programs to deliver preventative care to rural areas (12).

1997: Terre des Hommes: Child Survival Projects

The *Report of Preliminary KPC Survey is* a report of the child survival projects administered and funded by USAID Maputo. The introduction states that the constant civil war left all infrastructures within the country in ruins. Specifically, trained staff abandoned the healthcare sector, infrastructures were destroyed, and the Muanza and Cheringoma districts were completely cut off from the National Health System. These locations are the focus of this study. Reintegration into the National Health System began in 1995. This included re-assignment of trained staff to health posts (2).

Re-integration was limited by two key factors: Number of trained staff and accessibility of services to those in rural areas. The article states that the majority of families live 30-100kns away from district headquarters. The remainder of health-posts that may be accessible are manned by untrained staff (2-3).

Due to lack of access to health services, educating the community in basic health matters also plays a key role in the work of *TdH.* The following objectives outline the specific issues covered by *TdH.*

Objectives:

- Promotion of exclusive breast-feeding of infants for first 4 months.
- Promotion of use of oral rehydration therapy (ORT) for treatment of Diarrheas.
- Improvement of antenatal and postnatal Services.
- Improvement of vaccination coverage.
- Introduction and promotion of family planning initiatives.

This is a primary survey to gather base-line information for further use.

Percentages were given as well as discussion of findings.

Survey Question	Muanza District (70% live more than 1 hour away from health posts)	Cheringoma District
Infants less than 4 months being exclusively breast fed.	23%	14%
Children who had diarrhea in the past two weeks and given ORT.	24%	29%
Stunted children ages 6-23.	34%	37%
Mothers who received less than one antenatal visit with a trained healthcare professional.	24%	32%

Discussions (Summary)

Issues that are reported as a result of lack of education:

- Mothers are not exclusively breast-feeding children under 4 months.
- Mothers are introducing other forms of food to infants too early.
- High incidences of diarrhea.
- Loss of health cards due to lack of understanding of importance.
- Unaware of importance of antenatal and postnatal visits.

Concerns as a result of distance from health posts.

- In Muanza District there is a large proportion of malnourished children, unchecked diarrheal disease, measles, and intestinal parasites.
- 17% of mothers had professional health workers assist with births.

1997: Save the Children –Community based Health and Rural Development Project

This report is a final evaluation of the health program of the *Save the Children Federation Community based Health and Rural Development Project.* SCF has been in the Xai-Xai District of Gaza Province since 1988. Prior to 1993, civil war had caused many families to flee to the Limpopo River and the surrounding countryside until fighting ceased. SCF supported these displaced families in all aspects from healthcare, to food assistance. In 1994, many families wished to return home. However, war-torn infrastructures restricted them from doing so (1).

The following is an overview of the evaluation methodology within this evaluation. Sources of information for the evaluation include

- interviews with MOH provincial and district health staff
- discussions with SCF staff responsible for project implementation and monitoring
- community meetings
- site visits to newly constructed and rehabilitated health posts and staff housing units and interviews with the respective service providers
- exit interviews with service users
- personal observations
- focus groups

The assessment was largely qualitative. The evaluation examines the quality of projects as well as SCF's relationships with government, NGO and community partners in carrying out those activities (4).

Activity Areas:

- Training of community health workers.
- Rehabilitation/Construction of Health Posts.
- Strengthening Linkages between 26 rural communities and the formal health system.

Objectives:

- Empowerment through training and capacity building of community health workers.
- Physical and functional rehabilitation of service delivery infrastructure and networks.
- Forging linkages with government.

Key recommendations at end of report:

- Encourage District Health Staff to schedule regular refresher and supplementary training events for Community Health workers.
- Require target communities to submit plans for participation in development activities as well as compensation for volunteer health promoters and providers.

1998: Africa Bureau Results Package- Nutrition

Planned Key Areas That Need Improvement:

1. Increased African commitment to addressing nutrition related problems.
2. Strengthened African regional and national capacity to plan, manage, implement, and evaluate nutrition related programs.
    - Training packages will be integrated into regional and national institutions.

3. Existing and new approaches to improve nutrition related behaviors and practices at the population level developed, evaluated, and disseminated.
    - Lessons learned about targeting different levels of decision makers (community, district, national-level) and best practices should be disseminated.

1999: CARE Mozambique-Third Annual Report

Main project goal: "Reduce maternal, infant and child morbidity and mortality from selected preventable and treatable diseases in 129, 093 women and children 0-5 years living in 40 communities in three districts (Mecuburi, Malema, and Ribaue) of Nampula Province, from October 1, 1996 to September 30, 2000.

The project aims to improve selected health practices of both health providers and health services consumers."
Goals Met:

- 10% more complicated births dealt with in the health care system.
- 18% increase in women who gave birth with a qualified attendant.
- 80% of cases of pneumonia were properly classified, diagnosed and treated.
- 80% of malaria cases in children 0-5 years and mothers received proper diagnosis, classification, and treatment.
- 20% more caretakers properly caring for diarrhea.

Goals Not Achieved:

- Proportion of women who receive presumptive treatment of anemia during prenatal care.
- 80% of families in three communities participation in Malaria bed net pilot project.

Although statistics show improvement, a variety of factors hindered the success of these programs. These include:

- Weak infrastructure and management at the MOH.
- Lack of direction and clarity (roles and responsibilities) of Traditional Birth Attendants (TBAs).
- Absence of systematic support of the MOH following project-sponsored trainings considerably weakens the capacity building affect.

2000: Project Hope Improving Mother and Child Health in Ile District, Zambezia & Mozambique Final Report

Objective: Decrease mortality and morbidity in children under two and women of reproductive age and to increase involvement of local communities in developing solutions to local health problems.

Careful assessment was made of training needs of health staff, structured supervision, training materials, equipment and supplies.

This program struggled with the following problems:

- Geographic remoteness
- Project management
- Lack of infrastructure
- Shortage of public health professionals
- Morale and other personnel problems

The two major strategies used in this are

- Community education, training of healthcare volunteers
- Training and education of District Health Office (DDS) staff in improving planning, supervision, monitoring and information systems

Within the program there has been at least a 5.9% increase (up to 59%) on all areas surveyed. These include:

- % of children surveyed with diarrhea that received the same or more amount of liquids.
- % of children with diarrhea that were treated with Oral Rehydration Solution
- % of children between 12-23 with Measles vaccine
- % of mothers that had an immunization card

Diarrheal Disease
"The dramatic increase on practices during a child's diarrheal episode should be attributed to the work of project staff together with community health promoters and health workers from DDS, especially during the last 18 months of the project."

The items below were also discussed in the conclusions but made no reference to worker training having an influence on these areas:

- Immunization of children and women of reproductive age
- STD/HIV/AIDS
- Family Planning

2001: Ministry of Health: Evaluating Effective Use of Oral Rehydration Therapy

"Before revising Mozambique's diarrhoeal disease control strategy, studies were carried out to evaluate health centre management of diarrhea, the practicability of advice given to mothers and effective use of ORT in the home."

Results prompted a review of health worker training and supervision incorporating the need for health workers to find out from families what home-based ORS is feasible and to demonstrate the preparation of ORS using locally available utensils.

"We believe that this simple method of evaluation may be useful for other programs, both to identify problems in case management, especially health education, and to evaluate improvements after appropriately designed training has been carried out."

Note: This observation specifically deals with worker/patient contact…Patients were not receiving the education and support needed to administer ORS.

2001: Making Pregnancy Safer in Mozambique: A Human Rights Based Approach

Summary: Mozambique's largest health program, the National Integrated Program (PNI) focuses on mother and child health (MCH), family planning, immunization (EPI), nutrition, youth and school health, mental health, oral health and health education. It accounts for 40% of total outputs of the health system and targets 40% of the population.

Results of 1999 evaluation:

Weaknesses

- MCH/EPI staff represents only 22% of the total skilled workforce.
- Insufficient collaboration with other departments such as human resources.
- Insufficient communication between different levels of the healthcare system especially in areas of planning and supervision.
- Weak administrative capacity.
- Inadequate program monitoring and evaluation.
- The quality of maternal and newborn services is low due to inadequately skilled workers especially in rural areas.

Main constraints include: "insufficient number of skilled health providers, lack of material resources, shortage of funds, and inadequate management capacity at weak management information system."

Achievements

- Thorough assessments of Maternal Mortality Review (1998-99).
- Safe Motherhood Needs Assessment (1999).
- Detailed assessments for basic and comprehensive essential obstetric care (EOC) in seven provinces.
- Development of national strategy for the reduction of maternal and perinatal mortality and morbidity (200)
- Development of annual plans for PNI including provincial and district plans.
- Instituted training of health providers in basic and comprehensive EOC and interpersonal communication skills.
- One month training sessions on adolescent health have been completed in all provinces.

Future plans

- Decentralization, integration, and a sector-wide approach for health programs.
- Improvement of referral and communication systems.
- Comprehensive EOC and basic information systems to obtain data, which can be used to assess results and progress.
- Strengthening partnerships around the issue of safe motherhood to review priorities, assist the MOH in targeting existing resources, and mobilizing additional resources.
- Developing protocols and funding mechanisms for operations research.
- Reviewing laws, policies and regulations that impact the health of women and newborns.

Results

A case study analysis of the above reports and assessments reveals a common theme in the service delivery system, not only is training important, but the support given to healthcare workers after training is also vital. The first section of this analysis discusses a brief history of the infrastructure of the healthcare system in Mozambique. This is examined through one case study from 1986 as well as one essay written specifically on the history and impact of war in the country. Secondly, this paper examines the importance of worker training in improving quality of care. This research also found that there are several other variables and common barriers that are found within Mozambique's health sector. These include, lack of supervision to trained workers, clarification of roles and responsibilities of health staff and management as well as lack of communication between federal, state and local workers.

Background 1975-2001

At their independence in 1975, the healthcare infrastructure went through a reorganization period. At this time, the government began unifying the healthcare system. The National Health Service (NHS) was in charge of providing primary and secondary services to all citizens (Pavignani, 2001). By 1979, NHS health workers had reached 90 percent of population with vaccination programs. In addition, infant mortality had fallen 20 percent (Dev. Ed, 2001). Although growth and training activities took place over this time, large gaps in services between rural and urban areas remained. After independence, the South African apartheid regime waged war on Mozambique. This continuing threat hit rural areas hardest, and as people migrated to areas protected

by military, i.e. urban areas, the rural healthcare system dwindled (Pavignani, 2001). More importantly the training of service providers was under-resourced. As Pavignani states in his discussion on the healthcare system over the past 20 years: "Newly trained staff were mainly of low professional level, which, coupled with inadequate supervision and supply, resulted in low quality care (Pavignani, 2001). The first report examined reflects the early stages of reform in the healthcare sector.

Beginning with the *1986 Report on the Status of Malnutrition in Mozambique,* basic healthcare infrastructure was lacking. Lack of documentation in programming caused data to be scarce and insufficient in trying to carry out need assessments, keep personal records of clients, and eventually in successfully serving communities. This lack of basic data and infrastructure resulted in few programs available for communities (Selvaggio, 1986). The study reflects the consequences of political instability in the lack of infrastructure within the healthcare sector (Selvaggio, 1986). Political instability from the South African conflict (1981-1992) combined with natural disasters such as famine, drought, flood, and epidemics have contributed heavily to these issues. Pavignani also writes: "Poor infrastructure, severe shortages of skilled cadres, miserably low education levels, decades of cultural isolation, and severe economic dependence on neighboring countries" were all variables affecting healthcare at the time. The *1986 Report* reflects this lack of basic structure and due to this, training issues could not begin to be addressed. Page twelve of the report states that "primary health care services (including the provision of a clean, safe water supply) are available for only a small proportion of the Mozambican population, and there exists no…community health program to deliver preventative health care to more rural communities" (Selvaggio, 1986).

devoted to disease control (Healthcare in Africa, 2001). Of these types of healthcare, this report addresses health-worker training within programs in each of these service delivery systems. The specific programs fall under the World Health Organization's 1978 principals of health care services which include: equity in providing services especially to those most vulnerable; community involvement in planning; collaboration between health and other areas such as sanitation; health education; nutrition; safe water; maternal and child health and disease control (Healthcare in Africa, 2001).

According to the MOH, the most serious constraint affecting the healthcare system today is the lack of skilled workers. In 1992, the MOH launched a nationwide program to recruit and improve training of healthcare workers. Currently, physicians are trained at Faculty of Medicine in Maputo; other personnel such as nurses and midwives are trained at one of four Health Science Institutes in different provinces. In-service training however is not accessible to most health workers. Currently, plans are underway to make this possible (Dev Ed, 2001).

The shift to more in-service training derives from a desire to become more community oriented. This is especially important in rural areas. One article by the United Nations Population Fund focuses on ensuring skilled attendance at birth. This article states that in rural areas, where access to emergency obstetric surgery may not be available due to lack of skilled physicians, local nurses are trained to perform caesareans. This article states: "this has achieved outcomes as good as those performed by specialist obstetricians (UNFBA, 2001). As this example states, the quality and type of training that health workers received is critical in providing quality care. This example notes the

The period between 1986 and 1997 marked many changes for Mozambique. A new constitution was written in 1990 and in 1991 the Peace Agreement was signed. Rebuilding of the rural healthcare sector began. However, this slow and expensive venture was not appealing to healthcare workers. Due to landmines, and often unpassable roads, healthcare workers were reluctant to leave main towns (Pavignani, 2002). Two rural areas discussed later in this article, the Muanza and Cheringoma districts are among those isolated regions practically abandoned by the National Health System (Lagunja, 1997). In the mid 1990's, as displaced people returned home after war, health services were again demanded in once abandoned areas (MOH 1998). More qualified staff were hired and more updated equipment was provided. This made possible more effective evaluations of programs such as *Project HOPE, CARE* and other international relief agencies (Pavignani, 2001). This analysis of case reports and related articles discusses the impact of worker training on program effectiveness between 1997 and 2001.

Worker Training Today

Today, like most all sub-Saharan African countries, Mozambique's healthcare problems stem from commonly curable and preventable infections and parasitic diseases associated with basic hygiene and sanitation (Healthcare in Africa 2001, Dev Ed Notes 2001). Mozambique's the healthcare system is divided into three levels: the federal Ministry of Health (MOH), Provincial Health Directorates and District Health Directorates. Primary care within this region is delivered through four specific areas: the public healthcare system including government and nongovernmental agencies; the traditional healing system; for-profit western-style medicine; and programs specifically

benefits of training lower level workers to perform high-level skills necessary to providing equitable care throughout the country.

Worker training has expanded significantly in Mozambique within the past 12 years. The National Health Service (NHS) has restructured funding in several areas, one of these being an increase in funding toward worker training. The chart below, taken from Pavignani's report *The Reconstruction Process of the Health Sector in Mozambique* explains the 1997 status as well as target outcomes for 2002.

National staff employed by the NHS

Training Level **Year**

	1990	**1997**	***2002 Target***
Superior	207	424	470
Middle	865	1989	2720
Basic	5197	4264	5820
Elementary	1660	1583	1890
Ancillary	8231	6857	6350
Management		383	
Total	**16,160**	**15,500**	**17,250**

At the current pace, 2002 could meet target goals for training of healthcare staff at all levels. Many issues remain to be addressed when examining these positive statistics: the quality of training received; effectiveness of standardized training tools; and the remaining gaps between rural and urban healthcare. While the Ministry of Health reports that rural facilities are now better staffed along with gradual control of urban overcrowding, questions remain as to the continuation of such progress. Will donors

continue to fund $15 million dollars of training per year?[1] Will this be an issue for the state in the long run? Within the current system, donors such as USAID and World Health Organizations fund specific programs to enhance worker training. This is accomplished through providing grants to agencies such as Save the Children, Project HOPE, CARE and numerous others. This section will examine two specific program evaluation reports. Within these, this report will discuss the results of the program evaluations through similarities such as the importance of including training and incorporation of traditional healers in the healthcare system and training workers to effectively communicate with and educate communities.

Training Traditional Healers Within the Modern Healthcare System

Of all the public and private health systems within sub-Saharan Africa, the traditional system is the largest. It is estimated that there is one healer to every 350 to 2000 people (Health Care in Africa, 2001). The role of the traditional healer stems from the belief that illnesses are often caused by psychological or social conflict. Traditional healers focus on spiritual means of healing through ceremony, ritual and natural medicines (Hewson, 1998). .[2] The benefits of this type of healing are discussed in a study conducted by Mariana Hewson, PhD. In the study, Hewson discusses several aspects of traditional medicine that are rarely found in western healing. For example, traditional healers not only learn about the client's present medical condition, but also examine the patient's social and psychological well-being. Traditional healers also encourage patients to talk about their feelings, perceptions, and emotions in response to the illness. The healing process is also a ritual act in which the patient is actively involve

[1] Page 11 The Reconstruction Process in Mozambique
[2] Page 1 Traditional Healers

as opposed to western healing where the doctor is often perceived as knowing more than the patient about their illness.[3] Hewson's report does not attempt to state traditional medicine is more effective. On the contrary, there are times that western medicine is the best method of recovery. However, Hewson states that traditional medicine does provide spiritual, social and psychological benefits that western medicine often neglects (Hewson, 1998). This section discusses the impact of training traditional healers and incorporating them into the formal healthcare system.

The first two studies examined will be the *1997 Save the Children Federation Report* and the *1999 CARE Mozambique Report.* One key component found in these studies is the importance of training traditional or native healers. Both evaluations reflect this importance specifically due to collaboration efforts between the National Health Service and traditional healers in 1991. This took place for several reasons including lack of trained healthcare workers, lack of access to basic healthcare services of which large numbers of people were dying, and an interest by traditional healers to become more involved in allopathic medicine.

Save the Children Federation lists one objective under training as "improved human resources and skill development among health providers through provision of refresher courses." Their target was to train 10 district level Maternal and Child Health (MCH) nurses (province-wide). Training 11 nurses exceeded this goal. This training of supervisory nurses enhanced training of lower level workers including volunteer health promoters (activistas), traditional birth attendants (TBAs), and traditional healers (curandenos). As stated in the report "New linkages were forged and old ones

[3] Page 9 Traditional Healers in South Africa

strengthened between traditional and community-based networks and the formal health system (Save the Children, 1997). Like *SCF, CARE's* first strategy involves improving the quality of service delivery within the formal healthcare sector (health center and posts) and the nonformal system (community health workers, TBAs, and traditional healers). These "new linkages" discussed in both evaluations is visible in the following example taken from *CARE's* Annual Report:

Project Objective	*On Target to Achieve*	*Comments*
Increase to 10% of all births, the number of complicated obstetric cases managed in the healthcare system.	Yes	The project is assessing the physical and material conditions found in those health units that provide COB, and will upgrade the facilities. An emergency transport system is also being developed to address COB. All TBA trainings stress referral for complicated cases. CARE's technical support in Atlanta has developed indicators that will assist in determining the % of complicated deliveries attended in a health care facility.

The comment underlined serves as an example of the positive impact that collaborating formal and nonformal systems can have on quality of care.

The National Health Service found it beneficial to train traditional healers in the national healthcare system not only for the social and psychological benefits of its practices, but for the enhancement of community acceptance and involvement in programs. As stated in the April 2000 *Mozambique Final Country Report:* "In country

presence is a must and should be established from the beginning" (SEATS, 2000). "In country presence" or community acceptance can be achieved through gaining trust as well as community participation. One, the community must trust the international agencies that come into the community. This is reported in the *Mozambique Final Country Report* designed by the SEATS program. The results within this study examined not one specific program but four subprojects ran by PVOs in which the SEATS program was incorporated. From these programs, it was apparent that programs were far more effective if they were familiar to the communities (SEATS, 2000, p30). Second, along with community acceptance comes community participation. In the report documented by *Project HOPE* in July 2000, institutional sustainability relies largely on community involvement. The report states that community health workers and project coordinators form health committees whose main goal is to inform, motivate and encourage village women to participate in immunizations and other District Health Management Board activities (Sanabria, 2000).

If traditional medicine is most familiar to and already an aspect of the culture, it is only practical to include them in the mainstream healthcare sector. In addition, combining the benefits of modern medicine with the social, psychological and spiritual elements of traditional healing may prove to be the ideal design for quality healthcare. This is reflected in the both the *1997 SCF Report* and the *CARE Report. SCF* states: "SCF has instigated synergy between the traditional and modern approaches to healthcare, thereby increasing the overall impact of both systems" (Save the Children, 1997). This statement by *SCF* reflects the view of both the above programs to continue training of nonformal health workers within the formal sector.

The *SEATS* April 2000 report supports the importance of "in country" presence for the success of their programs for the improvement of reproductive health and education services. While training traditional healers is one method of improving quality of services, another important aspect is education of the community in basic health knowledge. How does this relate to worker training? The next section looks not at the amount of worker training, but what kind. What areas should be addressed when training healthcare workers? The following reports suggest that training healthcare workers to communicate more effectively with clients in areas such as educational programs incorporated into schools, explanation of common oral reydration techniques for mothers with infants, and encouraging clients to ask questions when seeing a physician are critical in providing quality care.

Training Workers to Communicate with and Educate Communities

With regard to the specific types of training that occurred in each of the studies, there was obviously some variation due to the very nature of the different types of projects conducted. For example, *Save the Children Federation* focused on training staff and traditional healers within the health clinics in Gaza province while *Ministry of Health's* report evaluated training of specific oral rehydration techniques. While the subject matter in each of the projects may have been slightly different, basic clinical techniques remain the same. One of these is the importance of educating communities in basic health knowledge. This knowledge encourages communities to be sustainable without the need of outside intervention. This obviously is only possible through the education of communities. Therefore, this remains a large component of the programs analyzed in this research. Programs such as the *Ministry of Health: Evaluating Effective*

Use of Oral Rehydration Therapy, Project Hope and *Mozambique Final Country Report* addressed these issues. They found that through increased instruction of healthcare workers on how to communicate with patients, helping patients become more involved in prevention and recovery (through asking questions of healthcare providers), and through training workers in creative ways of educating communities.

In the *Ministry of Health* report on *Evaluating Effective use of Oral Reydration Therapy*, program evaluators examined case management techniques of local healthcare worker in the health center by using a simple checklist. They also interviewed the parent of guardian immediately after the consultation. The problems found in the effectiveness of the program focused around lack of proper instruction given by healthcare workers on how to prepare reydration solutions. Parents stated that instruction was usually brief and demonstrations were rarely given (Ministry of Health, 2001). From this, the review has shown a need to review current health worker and supervision techniques in communication with families.

The Mozambique *Final Country Report* of the SEATS Program also discusses similar concerns for the improvement of client-worker communication. This program was specifically designed to be implemented into already existing programs such as *Save the Children Federation, Terre des Hommes,* and *Project HOPE.* SEATS main goal is to promote family planning and reproductive health in Mozambique (SEATS, 2000). Within this program evaluations were conducted on effective means of educating the community as well as effective clinical techniques used in promoting reproductive health. One major accomplishment noted by SEATS is the improved access to reproductive health services. Specific achievements within this are the establishment of specific youth

corners that operate in two already existing clinics. Peer educators have also been trained for seven schools. Creative arts have also been used in the enhancement of education. Such areas include theater, song and dance performances, group talks and debates.

Surveys called Quick Investigation of Quality (QIQ) were also conducted in two locations. In the areas where training was not given, nurses counseling and technical skills were not optimal and less than 60% encouraged clients to ask questions about their reproductive health. New clients were not screened properly nor were infection prevention measures taken consistently. However, in project areas that had received training, QIQ showed reductions in waiting time, and improved counseling skills, and improved topics of discussion during consultations (SEATS, 2000).

The 2000 *Project HOPE: Final Country Report* is a survey of program effectiveness for the *Providing Mother and Child Health in Ile District, Zambezia, Mozambique* program. One of the main objectives of this program is community education of mothers with children under two in preventing and health problems and limiting their severity. This was assessed by surveys on case management techniques and immunization along with a survey about practices about HIV/AIDS/STDs and family planning (Sanabria, 2000). The results of this final report conclude that immunization and family planning programs would be ineffective if not for community outreach teams that were trained and mobilized throughout the area. This is especially key in areas with greatly dispersed populations (Sanabria, 2000). The *1997 SCF* report shows similar improvements due to activistas. Training of Activistas promotes the following: "activistas are spurring increasing facility-based utilization rates and immunization

coverage rates through dissemination of appropriate Information, Education and Communication (IE&C) messages (SCF, 1997).

Forming Trust and Participation in Communities

What training methods can be utilized to form bonds of trust and community participation? Training of traditional healers mentioned earlier in the Community Education Section is one method. Using this method, program improvement is seen in the *1997 SCF* report. In a report from the National Association of Traditional Healers, the group expressed confidence in their limits as traditional healers and a willingness to refer families to modern health providers (SCF, 1997). As the report shows, education and awareness o f traditional healers to the benefits of modern medicine provide a valuable link to the community in promoting the importance of utilizing modern health clinics.

A second method is the importance of youth activities within the healthcare sector. Educating communities can begin with education of children and youth. For education of issues as life threatening as HIV/AIDS and other STDs, the SEATS program provided specific programs targeted toward youth. Youth corners were established in a local health center. According to the report, the corner had 23 trained peer educators to educate the community on the importance of reproductive health (SEATS, 2000).

Supervision and Monitoring of Trained Staff

This next section addresses the importance of supervision and monitoring of staff following training. Before examining the data, the importances of variables related to worker training were not acknowledged. However, the articles reviewed suggest that project specific supervision techniques following trainings are critical to the process of

quality assurance. This section discusses those findings within two articles *CARE Mozambique* and *Project HOPE.*

The need for continued monitoring and supervision after trainings is a reported need in both *CARE* and *Project HOPE* evaluations. The 1999 *CARE Mozambique Report* states that one factor that hinders quality of care at health posts is the absence of systematic support of the MOH following project-sponsored trainings (Purves, 2001). Within this challenge, the report states that communication between project directors and district-level health administrators (governmental staff) have been excellent; however, this does not excuse the fact that healthcare workers receive very little post-training evaluation. The report also states that one positive step in addressing this challenge is the arrival of new district-level directors. In addition, at a province-wide health conference in August 1999, MOH declared its intention of more regularly monitoring and supervising workers (Purves, 2001). Not only was this issue addressed in the "Problems and Solutions" section of the report, their was also a separate section specifically related to areas that require technical assistance. Two of the three project areas that require technical assistance relate to supervision and monitoring, those being monitoring from an outside consultant and assistance with training of trainers workshops. The third project area, technical assistance for end of project evaluation, although not directly related to on sight supervision, does play a role in the long term monitoring of program effectiveness (Purves, 2001).

Like *CARE,* monitoring and supervision are also addressed in the 2000 *Project HOPE Mozambique Final Report;* however problem areas lie not in the monitoring of staff, but in the supervision and direction of long-term goals. Their program to decrease

mortality and morbidity in children under two and women of reproductive age struggled with project management. The ineffectual management by *HOPE's* Country Director to initiate long-term planning and day-to-day activities was an issue that should have been addressed early on in the program. Due to reasons not mentioned in the study, the solution to this came regrettably 18 months after program implementation when the Program Director was dismissed. The report states that this is the prime reason that vaccination results were not as high as expected within the first phase of this program (Sanbria, 1997).

Several similar challenges are found in the 2001 article on *Making Pregnancy Safer in Mozambique.* The article sights an appraisal of the National Integrated Health Program. This 1999 evaluation points out the "Weaknesses" of the 1999 evaluation results as being the two areas addressed in earlier evaluations: Inadequate program monitoring, evaluation; and low quality due to inadequately skilled workers especially in rural areas. Recommendations from this study include training followed by continuous supervision. Supervision helps to retain new knowledge, and is more effective than training alone. Supervision should also include training and guidance, troubleshooting, as well as setting goals and objectives.

Capacity Building and Organizational Development

As discussed earlier, trained staff alone o little to benefit the healthcare sector. Trained staff requires support from several variables such as adequate number of staff; proper training in community education and communication; and proper monitoring and follow-up after training. Without these, training appears to be less effective. The combination of adequate numbers of trained staff that are knowledgeable about the

community and proper supervision and monitoring is a matter of program organization. How do we make programs more effective? Many agencies begin with capacity building or consultancy. United States Agency for International Development (USAID) has specific programs that aid in the efficiency of programs. Examples of this include BASICS I (1994-1999) and II (current). The goal of BASICS II is "to achieve the greatest possible country-level impact on major threats to child health providing technical leadership in policies and programming" (BASICSII, 2002). BASICS II, like many other similar agencies works with other USAID projects, PVOs, donor agencies, and faith-based agencies to achieve maximum program effectiveness. This section discusses the importance of capacity building throughout the program process. More importantly, it aims to show the importance and usefulness of worker training in the capacity building process.

One objective made in the *Project HOPE* program is to "train MOH health post and center staff in the technical content of project interventions, adult education methodologies and supervision skills. Therefore, *Project HOPE* designed district-wide quarterly evaluation and training sessions in which health post workers could brain storm by identifying areas in which they were not performing well. Health workers were then trained in techniques to address the situations before the next quarter (Sanabria, 2000). A similar region-wide initiative is seen in the following report. *1997 Save the Children Federation Report* includes an objective in improving quality by making it a requirement of target communities to submit plans for participation in development activities (SCF, 1997). Although the *Project HOPE* evaluation found strengths within district-wide planning, they failed to address the importance that incorporated worker training can

offer. In the *Lessons Learned* section of the report, evaluators found that the project trained staff from the MOH, however they did not bother to work with them to deliver services. Instead, each group, MOH and Project HOPE took their own area of activities. By doing so, HOPE could have given the District Health Management Board (DDS) leadership roles long before USAID program funding ended.

Conclusions

Since the 1980's, the healthcare system of Mozambique has made great improvements. However, they still face many challenges such as natural disasters, and continued political instability that hinders success. Despite these challenges, lessons have been learned in improving the overall quality of care for mothers and children in Mozambique. From the reports gathered in this study, the main areas in which the healthcare sector in Mozambique could be improved include:

- Improved communication between local, state, and national healthcare workers.
- Improved communication inside the delivery system such as healthcare workers to human resource workers.
- Increased, continuous training of healthcare providers combined with supervision and monitoring to ensure continued quality care.
- Trainings that include client-worker communication techniques and community education programs.

By evaluating and implementing these aspects of the healthcare system in Mozambique we can not only improve care in developing regions, but will have a better understanding of the healthcare delivery system in any setting.

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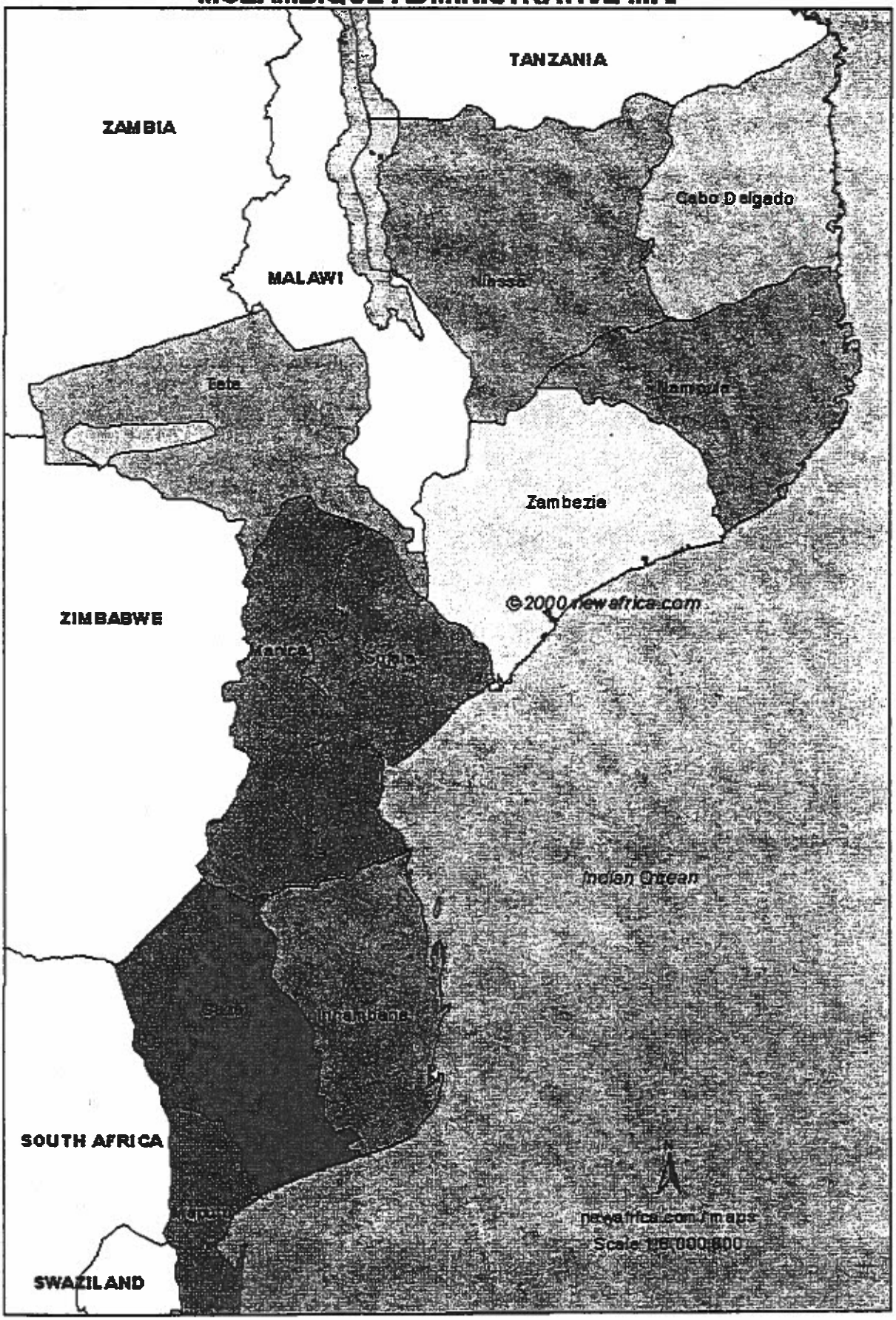
Appendix I

MOZAMBIQUE ADMINISTRATIVE MAP



Appendix II

MOZAMBIQUE OVERVIEW MAP